PB81-184418

Development Document for Proposed Effluent Limitations Guidelines, New Source Performance Standards, and Pretreatment Standards for the Iron and Steel Manufacturing Point Source

(U.S.) Environmental Protection Agency
Washington, DC

Dec 80

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 440/1-80/024-b-v3	2.	3. RECIPIENT'S ACCESSION NO. PB81-184418

4. TITLE AND SUBTITLE
Proposed Development Document for Effluent Limitations Guidelines & STandards for the Iron & Steel Manf. Point Source Category- Volume III - Steel Making, Vacuum Degas. & Continuous Costing Subcategories

5. REPORT DATE
December 1980

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
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Pittsburgh, PA 15220

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
U. S. Environmental Protection Agency
Effluent Guidelines Division WH-552
401 M. Street S.W., Washington, D.C. 20460

13. TYPE OF REPORT AND PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document (in six volumes) describes the technical basis for the proposed effluent limitations for the steel industry as published in the Federal Register (46 FR 1858) on January 7, 1981.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Steel Industry	Steel Industry Study	Steel Industry
Effluent Limitations	Steel - BAT Study	Permits
Treatment Technologies	Steel - Toxic Pollutants	Preparation

18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS *(This Report)* unclassified	21. NO. OF PAGES 513
	20. SECURITY CLASS *(This page)* unclassified	22. PRICE

EPA Form 2220-1 (9-73)

United States
Environmental Protection
Agency

Effluent Guidelines Division
WH-552
Washington, DC 20460

EPA 440/1-80/024-b
December 1980

Water and Waste Management

PB81-184418

EPA

Development Document for Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing

Proposed

Point Source Category

Vol. III

Steel Making Subcategory

Vacuum Degassing Subcategory

Continuous Casting Subcategory

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

DEVELOPMENT DOCUMENT

for

PROPOSED EFFLUENT LIMITATIONS GUIDELINES, NEW SOURCE PERFORMANCE STANDARDS,

and

PRETREATMENT STANDARDS

for the

IRON AND STEEL MANUFACTURING POINT SOURCE CATEGORY

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STEELMAKING SUBCATEGORY

SECTION I

PREFACE

The USEPA is proposing effluent limitations guidelines and standards for the steel industry. The proposed regulation contains effluent limitations guidelines for best practicable control technology currently available (BPT), best conventional pollutant control technology (BCT), and best available technology economically achievable (BAT) as well as pretreatment standards for new and existing sources (PSNS and PSES) and new source performance standards (NSPS), under Sections 301, 304, 306, 307, and 501 of the Clean Water Act.

This part of the Development Document highlights the technical aspects of EPA's study of the Steelmaking Subcategory of the Iron and Steel Industry. Volume I of the Development Document discusses issues pertaining to the industry in general, while other volumes relate to the remaining subcategories of the industry.

STEELMAKING SUBCATEGORY

SECTION II

CONCLUSIONS

This report highlights the technical aspects of EPA's study of the Steelmaking Subcategory of the Iron and Steel Manufacturing Category.

Based upon this current study and a review of previous studies, the Agency has reached the following conclusions.

1. Steelmaking operations, while reviewed collectively in this report, encompass the following three separate subdivisions:

   Basic Oxygen Furnace
   Open Hearth Furnace
   Electric Arc Furnace

2. While retaining the semi-wet air pollution control system segment of the BOF subdivision, the Agency has developed two additional subsegments of the wet air pollution control system segment to reflect variations between suppressed combustion and open combustion methods of gas collection and cleaning. The open hearth furnace subdivision was not segmented originally, however, the Agency has now segmented this subdivision to reflect distinctions between semi-wet and wet air pollution control systems. The semi-wet and wet segments of the electric arc furnace subdivision are being retained. The factors which were considered in evaluating the various segments include the type of gas cleaning system used, final product, raw materials, wastewater characteristics, wastewater treatability, size and age, geographic location, and process water usage.

3. The Agency is proposing BPT effluent limitations for the BOF and electric arc furnace subcategories which are identical to the originally promulgated BPT limitations for those operations. Although the suppressed combustion and open combustion segments of the BOF subdivision are separately recognized at the BAT level, the proposed basic oxygen furnace BPT limitations are applicable to all wet air pollution control system plants. Plants in both segments are achieving the proposed BPT limitations. The proposed BPT limitations for the newly developed semi-wet air pollution control segment of the open hearth furnace subdivision are the same as those originally promulgated for the semi-wet segments of the other two steelmaking subdivisions. The proposed BPT limitations for the open hearth furnace subdivision wet segment have been modified to reflect actual performance in the industry.

4. Sampling and analysis of process wastewaters from plants within each segment revealed significant concentrations of several toxic metal pollutants (cadmium, chromium, copper, lead, nickel, zinc,

and others). The discharges of these toxic pollutants can be reduced by available economically achievable technology. A summary of the discharges from the steelmaking subcategory at the proposed BPT and BAT levels of treatment are shown below:

	Effluent Discharges (Tons/Year)		
	Raw Waste	Proposed BPT	Proposed BAT & BCT
Flow (MGD)	284	13.5	13.5
TSS	1,258,000	1029	315
Toxic Metals	25,130	127	25
Fluoride	16,420	638	252

NOTE: Effluent discharges for PSES are included in those for BPT and BAT.

5. EPA estimates of the costs of compliance with the proposed BPT and BAT limitations are presented in Table II-1 for facilities in place as of January 1978. These costs are summarized below:

	Costs (Millions of July 1, 1978 Dollars)			
		Investment Costs		Annual
	Total	In Place	Required	Costs
BPT	151.8	127.8	24.0	38.0
BAT	15.2	0.9	14.3	3.6

NOTE: PSES costs are included in BPT and BAT costs. BCT costs are included in BAT costs.

6. Several responses from the industry indicate that recycle components (incoporated in the Agency's model treatment systems) are in use at steelmaking plants and present no significant problems pertaining to scaling, fouling, or plugging.

7. The Agency evaluated the "cost reasonableness" of controlling the conventional pollutant, TSS, and concludes that control costs of the model BCT systems for the BOF and open hearth wet segments are less than the POTW costs of treatment. The control costs for the electric arc furnace wet segment are greater than the POTW costs of treatment. Accordingly, EPA is proposing BCT effluent limitations for TSS in the wet segments of the BOF and open hearth subdivisions based on the application of the model BCT treatment systems. As the control costs for the electric arc furnace wet segment do not compare favorably with the POTW costs, the proposed BCT effluent limitations for TSS are the same as the proposed BPT limitations.

8. With one exception, the proposed NSPS for the steelmaking subdivisions are equivalent to the proposed BPT limitations for the semi-wet segments and to the proposed BAT limitations for the wet segments. The exception involves the absence of NSPS for the semi-wet and wet segments of the open hearth furnace subdivision. Due to economic and environmental disadvantages, open hearth furnace capacity has been and will continue to decrease, and is

being replaced with BOF or electric arc furnace steelmaking production capacity. Hence, the Agency does not expect any new open hearth furnace operations to be built.

9. EPA has proposed pretreatment standards for new and existing sources (PSNS and PSES) discharging to POTWs which limit the toxic pollutants which can be discharged. These standards are intended to minimize the impact of pollutants which would interfere with, pass through, or otherwise be incompatible with POTW operations and are generally equivalent to the proposed BAT limitations and NSPS.

10. Although several toxic pollutants were identified in raw wastewaters of each segment in each steelmaking subdivision, effluent limitations for each of these toxic pollutants are not necessary. Adequate treatment for the toxic metals in the wet air pollution control system segments is attained by controlling the discharges of the limited toxic metals. The effluent limitations for the semi-wet segments call for no discharge of process wastewater pollutants.

11. With regard to the remand issues, the Agency concludes that:

    a. None of the technologies incorporated in the various model treatment systems exhibit significant impacts on the consumptive use of water.

    b. Estimated treatment system costs are equally applicable whether the system is an initial fit or a retrofit. The ability to implement various wastewater treatment practices is not affected by plant age. The comparison of costs reported for plants, either visited or surveyed by D-DCPs, with the Agency's estimated costs for these plants, demonstrates that the estimated costs for the steelmaking segments and subdivisions are sufficient to account for site-specific and other incidental costs.

    c. With regard to the tight recycle systems, and the effluent flows incorporated in the BOF-wet model treatment systems, the data gathered during this study substantiate the ability of plants in each of the segments to achieve model effluent flows and recycle rates (refer to Section X). The data base for this study was obtained by sampling visits or from industry responses to DCPs and D-DCPs.

    d. The BAT alternative treatment systems for the open hearth wet segment presented in this report differ substantially from the treatment model presented in the 1974 document, based on the most recently obtained data. Also, the suspended solids levels upon which the proposed effluent limitations are based represent an analysis of extensive analytical data.

12. Table II-2 presents the treatment model flow and effluent quality data used to develop the proposed BPT effluent limitations for

the steelmaking subcategory, and Table II-3 presents these proposed limitations. Table II-4 presents the treatment model flow and effluent quality data used to develop the proposed BAT and BCT effluent limitations and the proposed NSPS, PSES, and PSNS for the steelmaking subcategory; Table II-5 presents these proposed limitations and standards.

TABLE II-1

WATER POLLUTION CONTROL COST SUMMARY
STEELMAKING SUBCATEGORY

(Costs[1] are expressed in millions of dollars)

		BPT			Proposed BAT		
Subdivision	Segment	Capital Investment (In-Place)	Capital Investment (Required)	Annual Cost of Operation	Capital Investment (In-Place)	Capital Investment (Required)	Annual Cost of Operation
Basic Oxygen Furnace	Semi-Wet	8.40	4.15	2.98	NA	NA	NA
	Wet-Suppressed Combustion	16.36	2.56	2.59	0.32	2.22	0.49
	Wet-Open Combustion	64.65	11.21	19.05	0.42	7.68	1.59
Open Hearth Furnace	Semi-Wet	2.86	0.64	0.85	NA	NA	NA
	Wet	13.82	2.38	3.81	0	2.36	1.14
Electric Arc Furnace	Semi-Wet	1.35	0.57	0.42	NA	NA	NA
	Wet	20.36	2.50	8.33	0.14	2.01	0.40

---

(1) Basis 7/1/78 dollars.
NA: Not applicable.

TABLE II-2

BPT TREATMENT MODEL FLOWS AND EFFLUENT QUALITIES
STEELMAKING SUBCATEGORY

Subdivision	Segment	Pollutant	Monthly Average Concentration (mg/l)[1]
Basic Oxygen Furnace	Semi-Wet	Flow, gal/ton	0
	Wet-Suppressed Combustion	Flow, gal/ton	50
		TSS	50
		pH, Units	6.0 to 9.0
	Wet-Open Combustion	Flow, gal/ton	50
		TSS	50
		pH, Units	6.0 to 9.0
Open Hearth Furnace	Semi-Wet	Flow, gal/ton	0
	Wet	Flow, gal/ton	110
		TSS	50
		pH, Units	6.0 to 9.0
Electric Arc Furnace	Semi-Wet	Flow, gal/ton	0
	Wet	Flow, gal/ton	50
		TSS	50
		pH, Units	6.0 to 9.0

---

(1) Daily maximum concentrations are three times the above monthly average concentrations.

TABLE II-3

PROPOSED BPT EFFLUENT LIMITATIONS
STEELMAKING SUBCATEGORY

Subdivison	Segment	Pollutant	Effluent Limitations (kg/kkg of Product)(1)
Basic Oxygen Furnace	Semi-Wet		(2)
	Wet-Suppressed Comubution	TSS	0.0104
		pH, Units	Within the range 6.0 to 9.0
	Wet-Open Combustion	TSS	0.0104
		pH, Units	Within the range 6.0 to 9.0
Open Hearth Furnace	Semi-Wet		(2)
	Wet	TSS	0.0229
		pH, Units	Within the range 6.0 to 9.0
Electric Arc Furnace	Semi-Wet		(2)
	Wet	TSS	0.0104
		pH, Units	Within the range 6.0 to 9.0

---

(1) Daily maximum effluent limitations are three times the above monthly average effluent limitations.
(2) No discharge of process wastewater pollutants to navigable waters.

TABLE II-4

TREATMENT MODEL FLOWS AND EFFLUENT QUALITIES
STEELMAKING SUBCATEGORY

Subdivision	Segment	Pollutant	Monthly Average Concentrations (mg/1)(1)				
			BAT	BCT	NSPS	PSES	PSNS
Basic Oxygen Furnace	Semi-Wet	Flow, gal/ton	0	0	0	0	0
	Wet-Suppressed Combustion	Flow, gal/ton	50	50	50	50	50
		TSS	-	15	15	-	-
		119 Chromium	0.10	-	0.10	0.10	0.10
		122 Lead	0.30	-	0.30	0.30	0.30
		128 Zinc	0.30	-	0.30	0.30	0.30
		pH, Units	-	6.0 to 9.0	6.0 to 9.0	-	-
	Wet-Open Combustion	Flow, gal/ton	65	65	65	65	65
		TSS	-	15	15	-	-
		119 Chromium	0.25	-	0.25	0.25	0.25
		122 Lead	0.25	-	0.25	0.25	0.25
		128 Zinc	0.30	-	0.30	0.30	0.30
		pH, Units	-	6.0 to 9.0	6.0 to 9.0	-	-
Open Hearth Furnace	Semi-Wet	Flow, gal/ton	0	0	(2)	0	(2)
	Wet	Flow, gal/ton	110	110	(2)	110	(2)
		TSS	-	15		-	
		119 Chromium	0.10	-		0.10	
		122 Lead	0.15	-		0.15	
		128 Zinc	0.30	-		0.30	
		pH, Units	-	6.0 to 9.0			
Electric Arc Furnace	Semi-Wet	Flow, gal/ton	0	0	0	0	0
	Wet	Flow, gal/ton	50	50	50	50	50
		TSS	-	50	15	-	-
		119 Chromium	0.15	-	0.15	0.15	0.15
		122 Lead	0.30	-	0.30	0.30	0.30
		128 Zinc	0.35	-	0.35 *	0.35	0.35
		pH, Units	-	6.0 to 9.0	6.0 to 9.0	-	-

---

(1) Daily maximum concentrations are the above monthly average concentrations multiplied by the following factors:

Pollutants(s)	Factor
TSS (for the Electric Arc Furnace-Wet BCT)	3.0
TSS (for all remaining Wet systems)	2.67
Chromium, Lead, Zinc	3.0

(2) An analysis of industry trends indicates that new open hearth furnaces will not be constructed. Therefore, no NSPS or PSNS are proposed for the Open Hearth Furnace subdivision.

TABLE II-5

PROPOSED EFFLUENT LIMITATIONS AND STANDARDS STEELMAKING SUBCATEGORY

Subdivision	Segment	Pollutant	Effluent Limitations and Standards (kg/kkg of Product)[1] BAT	BCT	NSPS	PSES	PSNS
Basic Oxygen Furnace	Semi-Wet	-	(2)	(2)	(2)	(2)	(2)
	Wet-Suppressed Combustion	TSS	-	313	313	-	-
		119 Chromium	2.08	-	2.08	2.08	2.08
		122 Lead	6.26	-	6.26	6.26	6.26
		128 Zinc	6.26	-	6.26	6.26	6.26
		pH, Units	-	Within the range 6.0 to 9.0		-	-
	Wet-Open Combustion	TSS	-	407	407	-	-
		119 Chromium	6.78	-	6.78	6.78	6.78
		122 Lead	6.78	-	6.78	6.78	6.78
		128 Zinc	8.13	-	8.13	8.13	8.13
		pH, Units	-	Within the range 6.0 to 9.0		-	-
Open Hearth Furnace	Semi-Wet	-	(2)	(2)	(3)	(2)	(3)
	Wet	TSS	-	688	(3)	-	(3)
		119 Chromium	4.59	-	(3)	4.59	(3)
		122 Lead	6.88	-	(3)	6.88	(3)
		128 Zinc	13.8	-	(3)	13.8	(3)
		pH, Units	-	Within the range 6.0 to 9.0	(3)	-	(3)
Electric Arc Furnace	Semi-Wet	-	(2)	(2)	(2)	(2)	(2)
	Wet	TSS	-	1,040	313	-	-
		119 Chromium	3.13	-	3.13	3.13	3.13
		122 Lead	6.26	-	6.26	6.26	6.26
		128 Zinc	7.30	-	7.30	7.30	7.30
		pH, Units	-	Within the range 6.0 to 9.0		-	-

---

(1) The proposed limitations and standards have been multiplied by 10^5 to obtain the values presented in this table. Daily maximum effluent limitations and standards are the above monthly average limitations and standards multiplied by the following factors:

Pollutants(s)	Factor
TSS (for the Electric Arc Furnace-Wet BCT)	3.0
TSS (for all remaining Wet systems)	2.67
Chromium, Lead, Zinc	3.0

(2) No discharge of process waste pollutants to navigable waters.

(3) An analysis of industry trends indicates that new open hearth furnaces will not be constructed. Therefore, no NSPS or PSNS are proposed for the Open Hearth Furnace subdivision.

STEELMAKING SUBCATEGORY

SECTION III

INTRODUCTION

General Discussion

Steel is an alloy of iron which contains less than 1.0% carbon. Steelmaking is basically a process in which carbon, silicon, phosphorus, manganese, and other impurities present in the raw hot metal or steel scrap, are oxidized to specific minimum levels. The hot steel is then either teemed into ingots or transferred to a continuous casting or pressure casting operation for direct conversion into a semi-finished product (i.e., slabs, blooms, or billets).

The basic raw materials for the steelmaking processes are hot metal or pig iron, steel scrap, limestone, burned lime, dolomite, fluorspar, iron ores, and iron bearing materials such as pellets, mill scale, or BOF or open hearth waste solids. The infinite variety of steel metallurgical specifications are produced by adding alloying agents either to the hot steel charge in the furnace or to the ladle of steel after the hot steel is tapped from the furnace into a teeming ladle. The major steelmaking processes are Basic Oxygen Furnace (BOF), Open Hearth Furnace (OH), and Electric Arc Furnace (EAF). Figure III-1 illustrates the process sequences involved in steelmaking.

The large quantities of airborne gases, dusts, smoke, and iron oxide fumes generated in the steelmaking process are collected and contained by gas cleaning systems, some of which use water for the cooling, conditioning and scrubbing of these waste gases and fumes. Depending on the type of gas cleaning system used, wastewater discharges or sludge generation can result. The following segments of the major steelmaking processes were selected to reflect the distinctions in the wet gas cleaning system discharges:

BOF (Basic Oxygen Furnace)

Semi-Wet
Wet - Suppressed Combustion
Wet - Open Combustion

OH (Open Hearth Furnace)

Semi-Wet
Wet

EAF (Electric Arc Furnace)

Semi-Wet
Wet

The semi-wet air pollution control systems use water to partially cool and condition the waste gases and fumes prior to final particulate removal in dry type collectors (i.e., precipitators or baghouses). The application of excess water for partial cooling and conditioning results in an aqueous discharge from these gas cleaning systems. Otherwise, zero discharge operations are possible.

Wet air pollution control systems use water not only to cool the waste gases but also to scrub the fume particulates from the waste gases. As a result of these water uses, wet gas cleaning systems discharge large volumes of wastewaters.

The wastewaters generated in the steelmaking process gas cleaning systems contain various pollutants which require treatment prior to discharge to receiving streams. This report reviews the characteristics and treatability of steelmaking process wastewaters, alternative treatment systems, and proposed effluent limitations for the steelmaking subcategory.

Data Collection Activities

To obtain process information and wastewater quality data, a total of twenty-three steelmaking plants (twelve BOF plants, four OH plants, and seven EAF plants) were visited and sampled. The effluent limitations promulgated in 1974 were based primarily upon data obtained through field sampling at eleven steelmaking plants. During the recent toxic pollutant survey, twelve additional steelmaking plants were sampled and one of the EAF plants sampled during the original survey was resampled. Table III-1 provides a summary of those steelmaking plants sampled during these surveys.

The general methodology and approach for soliciting data from the industry is described in Volume I. Through the DCP (basic questionnaire) responses, information regarding shop production capacities, modes of operation, applied and discharge flow data, and treatment facilities in use was provided for two hundred steelmaking plants. Tables III-2 through III-4 provide an inventory of the plants in each segment. Tables III-5 through III-10 summarize the data collected for each steelmaking segment.

In order to obtain additional data for long-term effluent quality, treatment costs, and other information, the Agency sent D-DCPs (detailed data questionnaires) to selected steelmaking operations. Responses were received for fourteen steelmaking plants (seven BOF plants, three OH plants, and four EAF plants).

Tables III-11 through III-17 summarize the data used in the development of this report.

Description of the Steelmaking Processes

A. Description of Basic Oxygen Furnace Operations

The basic oxygen furnace steelmaking process was introduced in the early 1950's and has become an important factor in the manufacturing of steel products. Basic oxygen furnace (BOF) steelmaking involves the production of steel in pear-shaped, refractory lined, open mouth furnaces using a mixture of hot iron (2500°F), cold steel scrap, and fluxes. Fluxes, such as burnt lime (CaO), produce a slag which collects the impurities and floats on the surface of the molten steel. Oxygen is injected into the furnace at supersonic velocities (Mach 2) through a water cooled, copper tipped steel lance for approximately twenty-five minutes. The lance is lowered through the furnace mouth and positioned about 60 inches above the surface of the bath. The high velocity of the oxygen causes violent agitation and intimate mixing with the molten iron with the resultant rapid oxidation of iron and dissolved carbon, silicon, manganese, and phosphorous.

The carbon in the steel bath combines with the oxygen to produce CO_2 and CO which are released from the furnace. Silicon, manganese, phosphorous, and other impurities oxidize into the slag. In order to maintain a fluid slag, fluorspar (CaF_2) is added to the bath at a rate of about 8 to 16 lbs per ton of steel. In addition, approximately 150 lbs of burnt lime is added per ton of steel to aid in the production of a floating slag. Since the BOF steelmaking process is exothermic (heat generating) a certain percentage of steel scrap can be melted without the use of external fuels. Generally, the furnace charge ratio is about 70% hot metal to 30% cold scrap.

The basic oxygen furnace, supported on trunnions mounted in bearings, is rotated when hot metal or scrap are added. In addition, the furnace is rotated for the tapping (pouring) of steel into ladles and the dumping of slag into slag pots. The tap to tap time involved in BOF steelmaking is approximately 45 minutes, with generally half of the time used for blowing oxygen. A BOF shop is generally equipped with two furnaces but sometimes three or more furnaces may be found within one shop. In a dual furnace shop, one furnace is operated while the other is either being reheated or relined. Some BOF shops practice swing blowing in which one furnace is blown with oxygen, while the other furnace is charged with raw materials.

Several variations of the conventional Linz-Donowitz furnace are employed by steel plants in the United States. Two of the more significant variations are the Kaldo process and the Q-BOP furnace. The Kaldo process is basically the same as the conventional top blown process with the exception that the Kaldo furnace is mounted in an inclined position and rotated during oxygen blowing. At present, there is only one Kaldo installation in the United States. The Q-BOP or bottom blown oxygen steelmaking process introduces pure oxygen along with carrier gases (such as natural gas, propane, nitrogen), and powdered fluxes (such as burnt lime) to the furnace through tuyeres located in the furnace bottom. The tuyeres are located in that half of the furnace bottom which is covered by molten steel so that when the furnace is in the tilted tapping position they are not exposed to wear. The furnace bottom is designed as a removable plug to allow for the easy replacement of the tuyeres. The addition of powdered fluxes through tuyeres prevents excessive slopping, and aids in the rapid formation of slag. Typical lime injection rates are on the order of five tons per minute. In this type of operation, oxygen is typically blown for ten to fifteen minutes. The Q-BOP furnace waste gas BTU content is somewhat higher than that of a conventional BOF due to the natural gas and propane content of the carrier gases. Because these fuel gases are added to the process, higher cold scrap charges can be used. The carrier gases also aid in cooling the tuyeres, thus minimizing wear. There are presently three Q-BOP installations in the United States.

The waste products from the basic oxygen steelmaking process include heat, airborne fluxes, slag, carbon monoxide and dioxide, and oxides of iron (FeO, Fe_2O_3, Fe_3O_4) emitted as submicron dust. Also, when the hot metal (iron) is poured into ladles or the furnace, submicron iron oxide fumes are released and some of the carbon in the iron is precipitated as graphite, commonly called "kish." Fumes and smoke are also released when the steel is poured from the furnace into steel holding (teeming) ladles. Approximately 1% to 2% of the ingot steel production is ejected as dust. All of these contaminants become airborne and thus, require removal. Basic oxygen furnaces are always equipped with air pollution control system for containing, cooling, and cleaning the huge volumes of hot gases and submicron fumes which are released in the process. Water is used to quench the off-gases to temperatures at which they can be effectively handled by the gas cleaning equipment.

During the oxygen blowing cycle, the primary gas constituent emitted from the BOF furnace is carbon monoxide (CO). The carbon monoxide gas (CO) will burn outside of the BOF furnace if allowed to come into contact with air. If outside air is prevented from coming into contact with the (CO) gas, combustion is retarded. This is referred to as suppressed combustion. Because the (CO) gas will burn when in contact with air, precipitators cannot be used due to the potential for an explosion as a result of arcing in the electric plates. Due to the hazards of explosions, suppressed combustion systems always use wet type scrubber systems.

Most BOF gas cleaning systems in use today furnish excess air for the burning of the CO gases. An open hood, mounted about 2 1/2 feet above the furnace mouth, is provided for the burning and conveying of gases and fumes to the air pollution control system. The hoods are made in several different geometric configurations (round, square, octagonal) and are either water cooled or used as waste heat, steam generating boilers. For the suppressed combustion system, the hood is mounted directly on top of the furnace. A section of the hood is retractable to provide access to the furnace for charging and pouring. The retractable hood can be adjusted to assure proper hood evacuation. The CO gas is then cleaned and burned at a flare stack, although provisions can also be made to collect and store the CO gas for future use as fuel.

The wet-open combustion gas cleaning systems are designed to accommodate gases and fumes from only one operating BOF. For a two furnace shop, the gas cleaning system is swung back and forth to each furnace by means of motor operated valves in the off-take ductwork. For three furnace shops, two separate gas cleaning systems are generally provided. The wet-suppressed combustion gas cleaning systems are also designed to handle gases and fumes from only one operating BOF. However, in these systems, one gas cleaning system is provided for each furnace. The suppressed combustion gas cleaning systems are not swung back and forth, as with the open combustion systems, in order to prevent air leakage and possible explosion.

There are four principal types of gas cleaning systems currently used on BOF's: dry, semi-wet, wet-suppressed combustion systems, and wet-open combustion. The first BOF shops, installed during the late 1950s, used precipitators as the primary gas cleaning systems. These systems were either of the dry or semi-wet type. From 1962 to 1970, the conventional open combustion, wet Venturi scrubber systems were installed. The present suppressed combustion systems were introduced in 1965 and have become the current wet gas cleaning technology. Following is a description of these four gas cleaning systems.

In the design of precipitator systems, two approaches are used for quenching or cooling the furnace off-gases prior to precipitator cleaning. One approach provides an exact balance between water applied and water evaporated. As no wastewaters or sludges are discharged in this case, such a system is defined as a dry precipitator system. This design uses an evaporation chamber to cool the hot gases. The design of the evaporation chamber, which is two to three times larger than the spark box of the semi-wet gas cleaning systems, requires its installation at the top of the BOF building structure. In the semi-wet systems, an excess of water is supplied to a spark box to cool the furnace gases, thus resulting in a process wastewater discharge. The spark box design has the advantage of reduced initial capital costs, however, additional capital expenditures for water pollution control equipment are required. The particulate matter collected in both precipitator systems is discharged as a dry dust.

Wet gas cleaning systems generally use quenchers and high energy Venturi scrubbers. The hot, particulate laden gases generated by the BOF process first pass through a primary quencher, where the gases are cooled with water and the heavier particles carried by the gas stream are removed. The gases are then conveyed to the Venturi scrubbers for final cleaning. Water is applied to the scrubber to capture the particulates and the resulting process wastewater is then pumped to the primary quencher. The quencher wastewater discharge is subsequently delivered to a wastewater treatment facility.

Both open and suppressed combustion furnaces employ wet scrubber systems. The open combustion gas cleaning system requires a greater pressure drop across the scrubber throat than the suppressed combustion system because of the relative sizes of the particulate matter carried by the gas stream. The particulate matter generated in a suppressed combustion system is larger and easier to remove from the gas stream and thus does not require a greater pressure drop. The suppressed combustion system provides only incomplete combustion with the result that only larger sized particles are generated. On the other hand, open combustion systems allow for more complete combustion, due to the presence of excess air, with the result that smaller particles are generated. Because of the greater pressure drop required in the open combustion venturi, this system will, consequently, consume more energy than a suppressed combustion system. Figures III-2 through III-8 illustrate the various gas cleaning systems employed at basic oxygen furnace operations.

B. Description of Open Hearth Furnace Operations

The open hearth process is the oldest of the primary steelmaking processes, having been introduced in the United States as early as 1868. The first commercial production of steel by this process began in 1888. The open hearth furnace became the primary method of making steel in the United States and reached its peak during the 1960s. Since that time, however, the use of open hearth furnaces has declined as a result of the development of the basic oxygen and electric arc furnaces.

The open hearth process produces steel in a shallow rectangular refractory basin, or hearth, enclosed by refractory lined walls and roof. The furnace front wall is furnished with water cooled, lined doors through which raw materials are charged into the furnace. A plugged tap hole at the base of the wall opposite to the doors is provided to tap the finished molten steel into ladles. Open hearth furnaces can use an all scrap steel charge; however, a 50% hot metal/50% steel scrap charge is typically used.

Fuel, oil, coke oven gas, natural gas, pitch, creosote, or tar is burned at one end of the hearth to generate heat for the melting of scrap and the production of steel. The type of fuel used depends upon plant economics and the availability of fuel. The hot gases resulting from the refining process and from fuel combustion travel the length of the hearth above the raw material charge, and are then conducted downward through a flue to a regenerative brick chamber called "checkerwork" or "checkers." These brick masses absorb heat, thereby cooling the waste gases to approximately 750°C to 850°C. The combustion system burners, checkers, and flues are duplicated at each end of the furnace thus permitting frequent and systematic reversal of the flue gas and combustion air flows. A system of valves in the flues effects the gas reversal, so that heat stored in the checkers is used to preheat the incoming furnace combustion air. Some plants convey the gases leaving the checkers through waste heat boilers to further reduce the waste gas temperature to 260°C to 315°C.

There are two principal types of open hearth furnaces: acid and basic. Where the basin refractory material is composed of silica sand, the furnace is termed an "acid" furnace. A furnace whose basin is lined with dolomite or magnesite is termed a "basic" furnace. The basic open hearth process is generally used in the United States because of its capacity to remove phosphorous and sulfur from iron and its ores. The acid furnace on the other hand, tolerates only minimal amounts of these elements and can use only selected raw materials. Open hearth furnaces are often grouped to form a shop with each furnace operating independently. One furnace in a shop is usually down (out of operation) for relining and other maintenance work. Steelmaking heats are scheduled in conjunction with down times in order to maintain the continuity of shop production.

The open hearth cycle is comprised of several stages, including fettling, charging, meltdown, hot metal addition, ore and lime boil, refining, tapping and delay. The period of time between tap and start, called "fettling," is spent in making repairs to the hearth and plugging the tap hole used in the previous heat. During the charging period, the solid raw materials such as pig iron, iron ore, limestone, and scrap iron and steel are dumped into the furnace by special charging machines. The melting period begins when the first scrap has been charged. The direction of the gas flow is then reversed every 15 to 20 minutes. When the solid material has melted, a charge of hot metal is put into the furnace. This is normal procedure for a "hot-metal" furnace, but in the case of a "cold metal" furnace, solid materials are usually added in two batch charges. The hot metal addition is followed by the "ore boil" and then the "lime boil" (caused by oxidized gases rising to the surface of the molten metal). Carbon monoxide is generated as a result of the oxidation of carbon and is released during the "ore boil." When carbon dioxide is released in the calcination of the limestone, the turbulence is called "lime boil." The refining period is used to lower the phosphorous and sulfur content of the steel to specified levels, to eliminate carbon, to allow time for proper conditioning of the slag and to attain proper bath temperature. At of the end the working period, the furnace is tapped, at which time the bath temperature is approximately 1,650°C. Typical tap to tap time for the production of steel in an open hearth furnace is normally eight to twelve hours. Sometimes pure oxygen is lanced over the steel bath to hasten the oxidation or refining cycle thereby reducing the tap to tap time to five to eight hours.

The waste products which result from the open hearth process are slag, oxides of iron ejected as submicron dust, waste gases (composed of air, carbon dioxide, and water vapor), oxides of sulfur and nitrogen (due to the nature of certain fuels being burned), and oxides of zinc (if galvanized steel scrap is used). Fluorides may be emitted from open hearth furnaces both as gaseous and particulate matter. In most instances, the source of fluoride is fluorspar (CaF_2), which is used during the final stage of the heat. Iron oxide fumes or dust is generated at the rate of 25 lbs/ton of steel. Gas and dust generation is fairly constant throughout the heat cycle except during oxygen lancing, when the gas and dust generation rates are highest.

Most of the particulate emissions from open hearth furnaces are iron oxides (predominantly Fe_2O_3). Fume generation rates are dependent upon the type of scrap used (i.e., galvanized), and the oil and dirt content of the scrap. Tests performed on open hearth furnaces indicate that the peak fume generation rates occur at the end of charging for a cold metal furnace and just after scrap addition for a hot metal furnace. Fume generation rates during oxygen lancing are approximately three times greater than that of typical operations. Also, the blowing of the checkers increases the fume generation rate.

Open hearth furnaces are generally equipped with some type of gas cleaning system to cool and scrub the hot gases emitted from the refractory checker system. The hot gases are cooled to approximately 870°C by the refractory checkers and are further cooled to 280°C by the gas cleaning system. The particulate matter carried by the gas stream is removed by one of the three basic gas cleaning systems: dry precipitator system, semi-wet system, or wet system. The gas cleaning systems may be manifolded designs which serve all the furnaces in a shop with one central gas cleaning system, or they can be independent systems which serve each furnace with a separate gas cleaning system.

In the design of precipitator systems, two approaches are used for the quenching or cooling of the furnace off gases prior to cleaning in the precipitator. One approach provides an exact balance between the water supplied for cooling and the water evaporated. This system does not discharge wastewaters or generate sludges and is, therefore, termed a dry precipitator system. The design of the evaporation chamber where the hot gases are cooled, necessitates its installation on the operating floor of the open hearth building. This chamber is two to three times larger than the spark box used in semi-wet gas cleaning systems. In the second approach, the semi-wet system, an excess of water is supplied to a spark box for the purpose of gas cooling. As a result, a process wastewater is generated. The spark box design has the advantage of reduced initial capital costs, however, additional capital expenditures for water pollution control equipment are required. The particulate matter collected in both precipitator systems is removed as a dry dust, although some plants slurry this dust and convey it to a thickener.

Wet gas cleaning systems generally use high energy Venturi scrubbers. The hot, particulate laden gases emanating from the refractory checkers are conveyed to Venturi scrubbers for cooling and cleaning. Water is applied at the scrubber to capture the particulates and cool the gases. The resulting wastewater effluent is subsequently discharged to a wastewater treatment facility. One open hearth shop uses a unique type of scrubber referred to as a "hydroscrubber." In this system, steam is used as the driving force for evacuating the gases from the furnace and also to clean of these gases. The steam is generated by a waste heat boiler located in the furnace shop.

Figures III-9 through III-11 illustrate the gas cleaning systems described above.

C. Description of Electric Arc Furnace Operations

The electric arc steelmaking process was introduced in the United States as early as 1878 and has since become one of the three principal methods of raw steel production. Commercial production of steel by this method began in 1899 and has since been steadily increasing. Until recently, electric arc furnaces (EAFs) had been used primarily for the production of alloy steels. However, EAFs are now used to produce a wide range of carbon and specialty steels.

The electric arc furnace steelmaking process produces high quality and alloy steels in refractory lined cylindrical furnaces using a cold steel scrap charge and fluxes. In some instances, a portion of hot metal or a lower grade of steel, produced in the basic oxygen or open hearth furnace, will be charged to the electric furnace. This procedure is referred to as duplexing. The heat for melting the furnace charge, and fluxes, is furnished by passing an electric current (arcing) through the scrap or steel bath between three cylindrical carbon electrodes, arranged in a triangle, which are inserted through the furnace roof. The electrodes are consumable and oxidize at a rate of 10 to 16 lbs/ton of steel. Larger tonnage furnaces have hinged removable roofs for scrap addition while smaller furnaces receive the charge through furnace doors. Furnaces range in capacity from 18 to 365 kkg (20 to 400 ton) heats and in size from 2 to 9 meters in diameter. The heat cycle time is generally four to five hours.

The production of some high quality steels requires the use of two different slags for the same heat (referred to as oxidizing and reducing slags). After removing the first slag from the furnace, new fluxes are added to produce the second slag. While the reducing slag is being formed, a slight positive pressure (with respect to atmospheric pressure) must be maintained in the furnace to prevent the infiltration of air or further oxidation of the steel. The heat cycle generally consists of the charging, meltdown, oxidizing, refining and tapping (pouring) steps. Pure oxygen is sometimes lanced across the bath to hasten the oxidation cycle which in turn reduces electrical power consumption.

A new process for refining alloy and stainless steels, the "AOD" or Argon Oxygen Decarburization process, was introduced in the early 1970s and has been used in conjunction with electric arc furnaces. The AOD furnace is similar in shape to a BOF vessel and generally handles a charge of 50 to 150 tons of hot steel. When the electric furnace is used in conjunction with AOD furnaces, the electric arc furnaces become carbon steel scrap melters. The hot metal charge is then transferred to the AOD process for final refining. This eliminates the double slag process used when electric arc furnaces are producing stainless and alloy steels. The AOD process allows for better control of the alloy steel composition as well as higher use of alloying agents such as ferrous chromium.

In the AOD process argon is injected through tuyeres in the AOD vessel bottom to refine the molten metal. Fluxes are added for the purpose of slag generation in the refining processes. The off-gases from the AOD vessel are conducted through hoods to baghouses where the particulates carried by the gas stream are removed. Hoods mounted above the AOD vessel mouth capture any fumes emitted. Generally, baghouse collectors are used as gas cleaning equipment, although at one plant, the off-gases are routed to the electric arc furnace wet fume scrubber system.

The waste products from the electric arc furnace process are smoke, slag, carbon monoxide and dioxide, and metal oxides (mainly iron) emitted as submicron fume. Other waste contaminants such as zinc oxides from galvanized scrap may be released depending upon the type and quality of scrap used. Oil bearing scrap will yield heavy reddish-black smoke as the oils are burned off at the start of the meltdown cycle. Nitrogen oxides and ozone are released during the arcing of electrodes. Generally, 10 lbs of dust/ton of steel is expected, but as much as 30 lbs of dust/ton of steel may be released if inferior scrap is used. To exhaust the fumes produced in an electric arc furnace, one of five different methods is generally used. These methods are:

1. Plant rooftop or furnace building extraction
2. Local fume hoods
3. Water cooled roof elbow
4. Fourth hole extraction
5. Total furnace enclosed extraction or "snuff box."

The plant roof top or building extraction method entails the sealing of the shop building and the installation of exhaust hoods in roof trusses. Huge volumes of air are exhausted with this system (1,300,000 cubic feet per minute for a shop consisting of five 50-ton furnaces). This system is readily adaptable to existing electric arc furnace shops using the double slagging practice and it captures most of the fugitive emissions from the other furnace operations such as tapping, or slagging. A baghouse collector is normally used to clean the exhaust gases in this system. As these systems are designed to clean the fumes from an entire furnace shop, adequate quantities of cooling air are introduced to the system to maintain proper temperatures. There is no wastewater discharge from this type of system.

The second type of furnace exhaust involves the use of local exhaust hoods fitted adjacent to door openings, electrode openings, and around junctures between the roof and the furnace shell. Fume, smoke, and gases are captured as they bleed through the furnace openings and enough cool air is drawn into the system so that the hot gases are tempered. A baghouse collector is also used with this system with the result that no process wastewaters are generated.

Water cooled roof elbows are generally tightly fitted to the furnace roofs and the hot gases are exhausted from the furnace interior through the cooled elbow. A combustion air space between the water cooled elbow and the gas cleaning ductwork provides combustion air for any carbon monoxide gases emitted from the furnace. As combustion results in high gas temperatures (approximately 1650°F), the gases must be water quenched or air cooled before entering the gas cleaning equipment. If spray chambers are used for quenching, a wastewater effluent is discharged.

The fourth hole extraction method is similar to water cooled elbows, except another hole, in addition to the three holes for the electrodes, is located in the furnace rooftop. A space between the ductwork and the fourth hole allows for the combustion of the gases. The gases are withdrawn from the furnace by suction through the fourth hole.

Baghouse collectors, precipitators or scrubbers are used for both the water cooled elbows and fourth hole extraction systems. If precipitators are used as the gas cleaning equipment, the hot off-gases from the furnaces have to be cooled to about 280°C in order for the precipitators to function. Higher temperatures could damage the precipitator. If baghouse fabric collectors are used, the off-gases must be cooled to 120°C as bag fabrics cannot withstand higher temperatures. Only fiberglass bags can withstand higher temperatures (400°C), however, these bags are more fragile. Spray chambers are used in conjunction with baghouses to assure proper cooling of the gases. If high energy Venturi scrubbers are used, the gases are quenched to their saturation temperature in quenchers located near the furnace.

Some electric arc furnace shops use long lengths of exhaust ductwork which act as heat exchangers. The hot gases are thus cooled by radiation of heat through the bare ductwork. Some shops use a similar cooling system called hairpin cooling heat exchangers. This method is generally used for the lower gas volumes of smaller furnace shops. One electric furnace shop, Plant 0528A, uses a spark box coupled with gas washers and disintegrators for wet cleaning of the off-gases.

The fifth gas collection method, "snuff box," encloses the entire furnace and exhausts the fumes through ductwork. The charging of scrap, and other material is accomplished by overhead cranes passing through automatic sliding doors in the enclosure around the furnace. This system can be used with Venturi scrubbers, precipitators or baghouses. In comparison to rooftop extraction, the "snuff box" allows for a greater reduction in exhausted gas volumes. Also, this system exhausts most of the fume emitted from the entire electric arc furnace, including the fume emitted during tapping.

The removal of the particulate matter carried by the gas stream is accomplished in one of the three basic gas cleaning systems: the dry, the semi-wet, and wet.

Dry gas cleaning systems are generally of two types, i.e., baghouses and electrostatic precipitators. A baghouse consists of a series of cloth or fiberglass bags which filter the water cooled furnace gases. The furnace gases are first quenched by water sprays in a spray chamber and are then introduced to the baghouse. Depending upon the type of baghouse, the dust transported by the gas stream collects either on the inside or on the outside of the filter bag. The bags are periodically shaken free of the dust which is then collected in hoppers located at the bottom of the baghouse structure. The dry dust thus collected is removed and landfilled. Another dry gas cleaning system uses the electrostatic precipitator. This system uses electrically charged metal plates to capture the charged particulate matter carried by the gas stream. As in the baghouse method, the gases must be water cooled prior to precipitator cleaning. Cooling of the furnace gases is accomplished in an evaporation chamber. The dust captured by the electrostatic precipitator is collected in a hopper and conveyed to a landfill. Neither of these gas cleaning systems results in a process wastewater or sludge discharge and, therefore, these systems do not require any water pollution control equipment.

The semi-wet system also involves the use of electrostatic precipitators, however, process wastewaters are generated. This system uses water to cool the furnace gases in a spark box chamber, which is about one- third the size of the evaporation chamber used for a dry system. An excess of water is supplied to the spark box to insure adequate cooling and, consequently, process wastewaters are discharged from the system. The spark box design has the advantage of reduced initial capital costs, however, additional capital expenditures for water pollution control are required.

Wet gas cleaning systems generally use high energy Venturi scrubbers. The hot, particulate laden gases from the furnace are conveyed to Venturi scrubbers for cooling and cleaning. Water is supplied to the scrubber to capture the particulates and to cool the gases. The wastewaters generated in this system are then discharged to a treatment facility.

Figures III-12 through III-15 illustrate some of the variations of gas cleaning systems employed in electric arc furnace shops.

TABLE III-1

PLANTS SAMPLED

	Sample Code	Reference Code
Basic Oxygen Furnace		
Semi-Wet		
	R	0432A
	U	0396D
Wet-Suppressed Combustion	S	0060
	032	0384A
	034	0856N
	038	0684F
Wet-Open Combustion	T	0112A
	V	0584F
	031	0020B
	033	0856B
	035	0868A
	036	0112D
Open Hearth Furnace		
Semi-Wet		
	043	0864A
Wet		
	W	0112A
	X	0060
	042	0492A
Electric Arc Furnace		
Semi-Wet		
	Y	0432C
	Z	0584A
	059B	0060F

TABLE III-1
PLANTS SAMPLED
PAGE 2

	Sample Code	Reference Code
Electric Arc Furnace		
Wet	AA(1)	0060F
	AB(2)	0868B
	051	0612
	052	0492A
	059A	0060F

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(1) Plant AA was resampled during the toxic pollutant survey in 1977 as Plant 059A.
The data gathered during the toxic survey is considered the most representative of recent plant operations and is therefore used in place of the original survey data.

(2) Plant AB has reported in their D-DCP that they have converted to dry precipitators and are no longer a wet system.

TABLE III-2

AN INVENTORY OF BASIC OXYGEN FURNACES

Reference Code	Sample Code	No. of Shops	No. of Furnaces
Dry			
0060B	-	1	2
0112	-	1	2
0256C	-	1	1
0320	-	1	2
0448A	-	1	3
0584A	-	2	4
0948C	-	1	2
		8	16
Semi-Wet			
0196A	-	**	**
0396D	U	1	2
0432A	R	1	4
0432C	-	1	2
0584C	-	1	2
0684B	-	1	2
0684G	-	1	2
0684I	-	1	2
0920B	-	1	2
0946A	-	1	2
		9 (1)	20 (1)
Wet-Suppressed Combustion			
0060	S	1	2
0384A	032	1	2
0528A	-	1	5
0684F	038	1	2
0684H	-	1	2
0856N	034	1	2
		6	15

TABLE III-2
AN INVENTORY OF BASIC
OXYGEN FURNACES
PAGE 2

Reference Code	Sample Code	No. of Shops	No. of Furnaces
Wet-Open Combustion			
0020B	031	1	2
0112A	T	1	2
0112B	-	1	3
0112D	036	1	2
0248A	-	1	2
0384A	-	1	2
0584F	V	1	2
0724A	-	1	3
0856B	033	1	2
0856R	-	1	2
0860B	-	2	6
0860H	-	1	3
0868A	035	1	2
0920N	-	1	2
		15	35

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(1) Total does not include confidential listing

**: Confidential

TABLE III-3

AN INVENTORY OF OPEN HEARTH FURNACES

	Reference Code	Sample Code	No. of Shops	No. of Furnaces
Dry	0112B	-	1	8
	0112C	-	1	8(1)
	0256E	-	1	5
	0384A	-	1	7
	0432B	-	1	6
	0448A	-	1	8
	0544A	-	1	4
	0632	-	1	3(2)
	0684F	-	1	4
	0684F	-	1	4
	0856H	-	1	9
	0856H	-	1	*
	0856T	-	1	*
	0860B(3)	-	2	*
	0864C	-	1	4
	0948A(4)	-	1	12
	0948B(4)	-	1	11
Semi-Wet	0864A	043	1	10
Wet	0060	X	1	6
	0112A	W	1	7
	0492A	042	1	5
	0948C(3)	-	*	*

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(1) Two furnaces shut down.
(2) Only one furnace is in operation.
(3) Open hearth shop idle since 1975.
(4) Open hearth shop shut down in 1978. This plant merged with 0432.

- : Not applicable
* : Inadequate DCP response

TABLE III-4

AN INVENTORY OF ELECTRIC ARC FURNACES

	Reference Code	Plant Code	No. of Shops	No. of Furnaces
Semi-Wet				
	0060F	059B	1	4
	0432C	Y	1	2
	0584A	Z	1	2
		TOTALS	3	8
Wet				
	0060D	-	1	3
	0060F	AA and 059A	1	2
	0492A	052	1	2
	0528A	-	1	3
	0612	051	1	2(1)
	0856F	-	1	5
	0860H	-	2	2
	0940	-	1	1
		TOTALS	9	20
Dry				
	0020B	-	1	5
	0020I	-	1	6
	0020K	-	1	1
	0032A	-	1	4
	0040A	-	1	1
	0044A	-	1	1
	0060G	-	1	4
	0060H	-	1	2
	0060I	-	1	4
	0060J	-	1	2
	0060K	-	1	2
	0068	-	1	2
	0068B	-	1	1
	0076	-	1	1
	0080B	-	1	2
	0084A	-	1	2
	0088A	-	3	9
	0112	-	1	5
	0112E	-	2	2

TABLE III-4
AN INVENTORY OF ELECTRIC ARC FURNACES
PAGE 2

Reference Code	Plant Code	No. of Shops	No. of Furnaces
0112F	-	1	3
0112G	-	1	2
0116	-	1	2
0132	-	1	2
0136B	-	1	2
0144	-	1	1
0148	-	1	2
0148A	-	1	2
0156A	-	1	1
0156B	-	1	1
0168	-	1	1(2)
0176	-	2	5
0176A	-	1	2
0180	-	1	Unknown
0188A	-	1	3
0188B	-	1	3
0188C	-	1	2
0196A	-	1	1
0204	-	1	1
0216	-	1	2
0236A	-	1	3
0240A	-	1	8
0248B	-	1	5
0256C	-	1	2
0256K	-	2	4
0256N	-	2	3
0260	-	1	1
0288A	-	1	1
0296A	-	1	1
0316	-	1	3
0316A	-	1	2
0316B	-	1	2
0320	-	1	3
0340A	-	1	2
0356B	-	2	3
0360	-	1	1
0384A	-	1	2
388A	-	1	2
0396E	-	1	3
0404	-	1	3

TABLE III-4
AN INVENTORY OF ELECTRIC ARC FURNACES
PAGE 3

Reference Code	Plant Code	No. of Shops	No. of Furnaces
0424	-	1	3
0424A	-	1	2
0430C	-	1	4
0432J	-	1	5
0436	-	1	2
0440A	-	1	4
0444	-	1	1
0456A	-	1	3
0460A	-	1	2
0468B	-	1	3
0468F	-	1	2
0472A	-	IR	IR
0476A	-	1	2
0496	-	1	2
0504A	-	1	3
0508A	-	1	2
0508C	-	1	3
0520	-	1	2
0544A	-	1	1
0548D	-	1	1
0560	-	1	2
0576	-	1	2
0576A	-	1	2
0596	-	1	2
0608A	-	1	1
0616A	-	1	2
0620A	-	1	2
0620B	-	1	2
0620C	-	2	2
0624B	-	1	2
0628A	-	1	1
0640	-	1	2
0640E	-	1	1
0652	-	1	2
0672A	-	1	2
0672B	-	1	2
0684E	-	4	9
0684H	-	1	3
0684U	-	1	2
0696A	-	1	2

TABLE III-4
AN INVENTORY OF ELECTRIC ARC FURNACES
PAGE 4

Reference Code	Plant Code	No. of Shops	No. of Furnaces
0724A	-	1	2
0736	-	1	8
0740A	-	1	2
0764	-	1	2
0776E	-	1	1R
0776G	-	1	1
0780	-	2	3
0784	-	1	4
0796A	-	1	7(3)
0796C	-	1	3(3)
0804A	-	1	6
0804B	-	1	1
0804B	-	IR	IR
0856R	-	1	5
0868B	AB(4)	1	2
0896	-	1	2
0900A	-	1	2
	TOTALS	127	290

---

(1) One AOD furnace
(2) Also 2 vacuum induction furnaces and 20 vacuum consumable electric furnaces. These furnaces are not included in the totals.
(3) Also 2 vaccum induction furnaces. These furnaces are also not included in the totals.
(4) Plant AB was sampled as a wet discharge plant in 1974. The plant has since converted to a dry system.

- : Plant was not sampled, therefore, no plant code was assigned.
IR: Inadequate DCP response.

TABLE III-5

GENERAL SUMMARY TABLE
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - SEMI-WET

					Production (tons/day)		Flows (gallon/ton)		Treatment Components			
Plant Code	# of Furnaces	Steelmaking Process	Furnace Age-1st Yr.Prod.	Type of Steel	Rated Capacity	1976 Production	Applied Flow	Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0196A	**	L-D	**	**	**	**	**	**	CL	None	OT	Direct
0396D	2	Interlake	1959	CS-100	2,400	2,451	132	13(1)	PSP,FLP,CL,VF	None	RTP 90.5 RET 9.5	Indirect
0432A	3	L-D	1968	CS-50,HSLA-40, Other-10	9,600	6,700	149	0	DR,FLP	None	RTP 100	Zero Discharge
0432C	2	L-D	1961	CS-87.2,HSLA-4.6,ES-8.2	6,585	6,271	32	11	PSP	VF,FLL,FLO1, CL,PSP	OT	Indirect
0584C	2	Top blown	1968	CS-91.4,HSLA-6.4,ES-2.2	6,900	5,291	295	217	PSP	SS,SL, CLB,FDBS,02	OT	Direct
0684B	2	L-D	1965	CS-88,HSLA-6, ES-6	7,120	5,493	184	52	FLP,PSP	None	OT	Direct
0684G	2	L-D	1970	CS-81,AT-19	4,536	2,680	672	430	DR	Unknown	OT	Direct
0684I	2	L-D	1965	CS-85,HSLA-15	4,500	3,087	280	124	DR	Unknown	OT	Direct
0920B	2	IR	1964	CS-95,HSLA-5	4,300	3,776	IR	0(2)	None	None	NA	Evaporation
0946A	2	L-D	1964	CS-87,HSLA-13	3,480	1,766	1,302	82	PSP,VF	None	BD 6.3 RTP 93.7	POTW

---

(1) Blowdown used for dust control at slag processing operation.
(2) Process water is entirely evaporated.
**: Confidential data

Steelmaking Process

L-D: Linz-Donowitz

Types of Steel

CS: Carbon Steel
AT: Alloy Tool Steel
ES: Electrical Steel
HSLA: High Strength Low Alloy

Additional Footnotes

IR: Inadequate company response
NA: Not applicable
FLO1: Flocculation with ferric chloride
02: Dechlorination with SO_2

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE III-6

GENERAL SUMMARY TABLE
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

Plant Code	# of Furnaces	Steelmaking Process	Furnace Age - 1st Year of Production	Type of Steel	Production (tons/day) Rated Capacity	Production (tons/day) 1976 Production	Flows (gallon/ton) Applied Flow	Flows (gallon/ton) Discharge Flow	Treatment Components Process Treatment	Treatment Components Central Treatment	Operating Mode	Discharge Mode
0060	2	OG	1969	CS-95, HSLA-5	7599	5795	1897	75	Classifier, FLP, CL, VF	None	RTP 96.0 BD 4.0	Direct
0384A	2	Minimum Combustion	1974	CS-90, HSLA-9, ES-1	6000	5424	[1327]	[80]	Classifier, T, CL	None	RTP 94.0 BD 6.0	Direct
0528A	5	L-D	1955	CS-90, HSLA-10	6000	5502	1818	1818	Settling Basins	PSP, CL, T, CY	OT	Direct
0684F	2	L-D	1966	CS-96, HSLA-4	9800	7840	[569]	[33]	DR	FLP, T, SS, NA, VF, NL, FLL, FLP, FLO1, CL	RTP 94.2 BD 5.8	Direct
0684H	2	Q-BOP	1977	CS-98.3, Other-1.7	7168	6380(1)	[1129]	[113]	FLP, TP, T, CT, VF	None	RTP 90.0 BD 10.0	POTW
0856N	2	L-D	1971	CS-90, HSLA-10	7700	7100	[1278]	[39]	CL, FLP, T	None	RTP 96.9 BD 3.1	Direct

---

(1) New shop which was not operational in 1976. Tonnage figure is therefore average production.
[ ]: Data enclosed in brackets was provided in D-DCP responses or obtained during sampling visits.

Steelmaking Process

OG: Off Gas
L-D : Linz-Donowitz

Types of Steel

CS : Carbon Steel
ES : Electrical Steel
HSLA: High strength low alloy

Additional Footnotes

FLO1: Flocculation with ferric chloride

NOTE: For a definition of other C&TT Codes, refer to Table VII-1.

TABLE III-7

GENERAL SUMMARY TABLE
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

Plant Code	# of Furnaces	Steelmaking Process	Furnace Age - 1st Year of Production	Type of Steel	Production (tons/day) Rated Capacity	Production (tons/day) 1976 Production	Flows (gallon/ton) Applied Flow	Flows (gallon/ton) Discharge Flow	Treatment Components Process Treatment	Treatment Components Central Treatment	Operating Mode	Discharge Mode
0020B	2	**	**	**	**	**	**	**	None	CL,FLL, FLP,VF	RUP 71.9 BD 28.1	Direct
0112A	2	L-D	1966	CS-100	9,167	8,903	1,315	437	FLP,T	None	RTP 66.8 BD 33.2	Direct
0112B	3	L-D	1964	CS-85,HSLA-15	14,400	9,397	1,824	1,801	T,CL,VF	None	OT	Direct
0112D	2	L-D	1969	CS-66,HSLA-34	12,050	10,520	[454]	[244]	Classifiers, FLP,T,CY	NL,NW,NA, FLP,CL,SS, T,SL	RTP 46.3 BD 53.7	Direct
0248A	2	TOC	1968	CS-90,AT-10	2,400	2,085	2,072	1,934	NA	T,VF,FLP	OT	Direct
0384A	2	L-D	1966	CS-94,HSLA-5, ES-1	11,200	10,175	977	99	T	None	RTP 89.1 BD 10.1	Direct
0584F	2	BOP	1967	CS-100	11,690	9,892	[262]	[65]	CL,FLP,VF	SL	RTP 75.2 BD 24.8	Direct
0724A	2 1	KALDO L-D	1962 1974	CS-100	3,500	2,310	[1,558]	[312]	CL,FLP,VF	None	RTP 80.0 BD 20.0	Direct
0856B	2	Suspended Combustion	1972	CS-100	7,750	7,283	[241]	[241]	Classifier, CY,VF	None	OT	Direct
0856N	2	L-D	1963	CS-77,AS-10 HSLA-9,ES-4	7,500	6,109	1,296	118	T,VF	None	RUP 90.9 BD 9.1	Direct
0860B	3	BOP	1965	CS-94.7,AS-4.5,HSLA-0.8	12,400	10,762	1,285	201	SCR,CL,SL,SS, CY,VF	None	RTP 84.4 BD 15.6	Direct
0860B	3	Q-BOP	1973	CS-91,AS-6.1 HSLA-2.9	15,000	11,875	[1,263]	[146]	SCR,CL,SL,SS, VF,CT	None	RTP 88.4 BD 11.6	Direct
0860H	3	L-D	1969	CS-84.8,HSLA+ AT+ES-15.2	11,200	7,091	1,946	1,596	DR,T,VF, FLP,NA,CY	CL,CT	RUP 18.0 RET 82.0	Indirect
0868A	2	Q-BOP	1974	CS-100	7,440	6,198	[1,046]	[113]	FLP,CL,VF	None	RTP 89.2 BD 10.8	Direct
0920N	2	L-D	1965	CS-100	8,550	7,707	227	149	Classifier, T,VF	None	RTP 34.4 BD 65.6	Direct

---

** : Confidential data
[ ] : Data enclosed in brackets was provided in D-DCP responses or obtained during sampling visits.

Steelmaking Process

L-D :	Linz-Donowitz
TOC :	Top blown oxygen converter

Types of Steel

CS :	Carbon steel
AS :	Alloy steel
AT :	Alloy tool steel
ES :	Electrical steel
HSLA:	High strength low alloy

NOTE: For a definition of C&TT Codes, refer to Table VII-1.

TABLE III-8

GENERAL SUMMARY TABLE
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACE

	# of Furnaces					Prod. (tons/day)		Flows (gal/ton)		Treatment Components			
Plant Code	Total	Recently Active	Type of Furnace	Furnace Age-1st Yr.Prod.	Type of Steel	Rated Capacity	1976 Prod.	Applied Flow	Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
Semi-Wet													
0864A	10	6-7	OI	1944	CS-90.2, HSLA-9.8	6,550	5867	[1117]	[69]	T,CL>FLL>FLP	SL	RTP 93.8 BD 6.2	Direct
Wet													
0060	6	6	OI & Basic	1952	CS-95, HSLA-5	5,507	2754	[4392]	[105]	CL>HC>VF> FLP>NL>CL	None	RTP 97.6 BD 2.4	Direct
0112A	7	7	OI & Basic	4 FCES-1957 3 FCES-1958	CS-100	10,822	6304	[914]	[114]	T>FLP	None	RUP & RPT 87.5 BD 12.5	Direct
0492A	5	2-5	OI & Basic	1953	CS-97, HSLA-3	3,835	3048	[506]	[359]	FLP,NL,CL, VF	SL	RTP 29.1 BD 70.9	Direct
0948C(1)	8	4	OI & Basic	6 FCES-1952 2 FCES-1953	CS-97, HSLA-3	7,600	3225(2)	2679	80	Classifier,T, Scr,SL,CT	None	RTP 97.0 BD 3.0	Direct

---

(1) Merged with 0432. Open Hearth shop idle since 1975.
(2) 1975 production
[ ]: Data enclosed in brackets was provided in D-DCP responses or obtained during sampling visits.

Type of Furnace

OI: Oxygen Injection

Types of Steel

CS: Carbon Steel
HSLA: High Strength Low Alloy

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE III-9

GENERAL SUMMARY TABLE
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE - SEMI-WET

Plant Code	No. of Furnaces	Furnace Age 1st Yr.Prod.	Type of Steel	Production (tons/day) Rated Capacity	Production (tons/day) 1976 Production	Flows (gallons/ton) Applied Flow	Flows (gallons/ton) Discharge Flow	Treatment Components Process Treatment	Treatment Components Central Treatment	Operating Mode	Discharge Mode
0060F	4	1966	CS-85,HSLA-15	3900	2081	[23.7]	[20.6]	CL,VF	SL	RET (UNK) BD (UNK)	Direct
0432C	2	1959	CS-89.5,HSLA-10.5	2280	2118	272	272	PSP	PSP,CL,FLP, FLL,FL01,VF	RET 100	Indirect(1)
0584A(2)	2	1968	CS-85,HSLA-15	(3)	1903	IR	0	NA	NA	NA	Zero Discharge

---

(1) Effluent is reused in the slabbing mill, treated in a central treatment facility and discharged.

(2) The DCP lists this system as dry and provides only limited information. The plant, however, has a semi-wet system and maintains a balance between water applied and water evaporated. The only discharge from this system is a wet sludge from the spark box.

(3) The DCP reports that capacity is dependent upon charge material, power, O_2 rates, etc.

[ ] : Data enclosed in brackets was obtained during a sampling visit.
IR : Inadequate response.

Types of Steel

CS: Carbon Steel
HSLA: High Strength Low Alloy

Additional Footnotes

NA: Not Applicable
FL01: Flocculation with ferric chloride

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE III-10

GENERAL SUMMARY TABLE
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE - WET

				Production (tons/day)		Flows (gallons/ton)		Treatment Components			
Plant Code	No. of Furnaces	Furnace Age-1st Yr.Prod.	Type of Steel	Rated Capacity	1976 Production	Applied Flow	Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0060D	3	1969	ES-63,CS-15, HSLA-12,SS-10	2500	2520	[829]	[232]	CR, Classifier, CL,VF	None	RTP 72.0 BD 28.0	Direct
0060F	2	1951	CS-50.6,HSLA-49.4	1100	949	[2300]	[238]	Classifier, CL,VF	None	RUP&RTP 89.7 BD&RET 10.3	Direct
0492A(1)	2	1976	-	900	525	[1178]	[836]	None	NL,FLP,CL, VF	RTP 29.0 RET 71.0	Zero(2) Discharge
0528A	2	1949	CS-66,SS-34	1150	410	3512	3512	PSP	CL,T,CY, NA,FLP,VF	OT	Direct
0612	3	1968 1971,1976	CS-100	5500	3068	[2412]	[45]	CL,VF	None	RTP & RUP 98.1 RET 1.9	Zero(2) Discharge
0856F	2	1972	CS-100	1600	535(3)	2092(3)	104(3)	SL	None	RTP 95.0 BD 5.0	Direct
0860H(4)	2	1975	SS-88.6,CS-10.9, HSLA,AT,ES-0.5	463	544	2353	776	Classifier, T,VF	CL,CT	RUP 67.0 RET 33.0	Zero(2) Discharge
0860H	2	1971	CS-86.9,HSLA,AT, ES-13.1	1985	1914	2330	1212	Classifier, T,VF	CL,CT	RUP 48.0 RET 52.0	Zero(2) Discharge
0868B(5)	2	1971	CS-78.5,HSLA21.5	1560	1536	[2625]	[234]	Classifier, T,CY,SL	None	RTP 91.1 BD 8.9	Direct
0940	1	1967	CS-100	175	126	-	0	None	None	RUP 100	Zero Discharge

---

(1) New shop, no DCP was submitted. The data presented for this plant represent information obtained during the sampling visit.
(2) Process water is reused throughout the plant.
(3) In comparison to reported typical production, the 1976 production was considered to be atypical. Therefore flow determinations were calculated on the basis of 1975 production values. The tonnage shown represents 1976 production.
(4) An A.O.D. furnace is coupled with this furnace system.
(5) The D-DCP reported that this plant converted to a dry system in 1977.

[ ]: Data enclosed in brackets was provided in D-DCP responses or obtained during sampling visits.

Types of Steel

CS: Carbon steel
AT: Alloy tool steel
ES: Electrical steel
HSLA: High strength low alloy
SS: Stainless steel

NOTE: For a definintion of C&TT codes, refer to Table VII-1.

TABLE III-11

STEELMAKING SUBCATEGORY DATA BASE
BASIC OXYGEN FURNACE - SEMI-WET

	No. of Plants	% of Total No. of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	2	20	12,000	24.0
Plants sampled for toxic pollutant study	0	0	0	0
Total plants sampled	2	20	12,000	24.0
Plants responding via D-DCP	0	0	0	0
Plants sampled and/or responding via D-DCP	2	20	12,000	22.7
Plants responding to DCP	10	100	49,921(1)	100

---

(1) Does not include the production of one plant which claimed confidentiality.

TABLE III-12

STEELMAKING SUBCATEGORY DATA BASE
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

	No. of Plants	% of Total No. of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	1	16.7	7,599	17.2
Plants sampled for toxic pollutant study	3	50	23,500	53.1
Total plants sampled	4	66.7	31,099	70.3
Plants responding via D-DCP	3 incl. 2 above	50 incl. 33.3 above	20,868 incl. 13,700 above	47.1 incl. 30.9 above
Plants sampled and/or responding via D-DCP	5	83.3	32,267	86.4
Plants responding to DCP	6	100.0	44,267	100.0

TABLE III-13

STEELMAKING SUBCATEGORY DATA BASE
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

	No. of Plants	% of Total No. of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	2	14.3	20,857	15.5
Plants sampled for toxic pollutant study	4	28.6	27,240(1)	20.3
Total plants sampled	6	42.9	48,097(1)	35.8
Plants responding via D-DCP	4 incl. 2 above	28.6 incl. 14.3 above	30,190(1) incl. 11,690(1) above	22.5 incl. 8.7 above
Plants sampled and/or responding via D-DCP	8	57.1	66,597(1)	49.6
Plants responding to DCP	14	100.0	134,247(1)	100.0

---

(1) Does not include the data from one plant which claimed confidentiality.

TABLE III-14

STEELMAKING SUBCATEGORY DATA BASE
OPEN HEARTH FURNACE - SEMI-WET

	No. of Plants	% of Total No. of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	0	0	0	0
Plants sampled for toxic pollutant study	1	100	6550	100
Total plants sampled	1	100	6550	100
Plants responding via D-DCP	1 incl. 1 above	100 incl. 100 above	6550 incl. 6550 above	100 incl. 100 above
Plants sampled and/or responding via D-DCP	1	100	6550	100
Plants responding to DCP	1	100	6550	100

TABLE III-15

STEELMAKING SUBCATEGORY DATA BASE
OPEN HEARTH FURNACE - WET

	No. of Plants	% of Total No. of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	2	66.7	16,329	81.0
Plants sampled for toxic pollutant study	1	33.3	3835	19.0
Total plants sampled	3	100.0	20,164	100
Plants responding via D-DCP	2 incl. 2 above	66.7 incl. 66.7 above	16,329 incl. 16,329 above	81.0 incl. 81.0 above
Plants sampled and/or responding via D-DCP	3	100.0	20,164	100.0
Plants responding to DCP	3	100.0	20,164	100.0

TABLE III-16

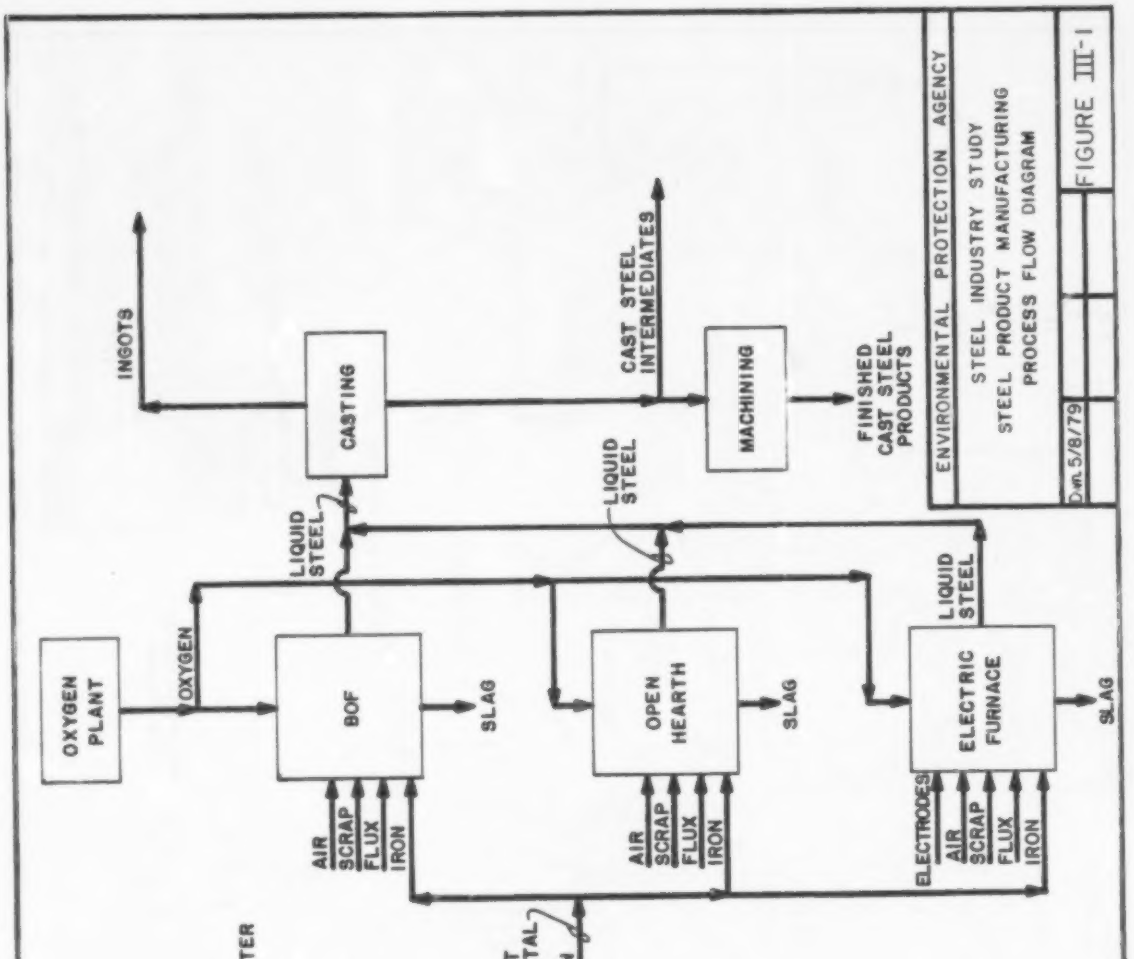
STEELMAKING SUBCATEGORY DATA BASE
ELECTRIC ARC FURNACE - SEMI-WET

	No. of Plants	% of Total No of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	2	66.7	4183	51.8
Plants sampled for toxic pollutant study	1	33.3	3900	48.2
Total plants sampled	3	100.0	8083	100.0
Plants responding via D-DCP	0	0.0	0.0	0.0
Plants sampled and/or responding via D-DCP	3	100.0	8083	100.0
Plants responding to DCP	3	100.0	8083	100.0

TABLE III-17

STEELMAKING SUBCATEGORY DATA BASE
ELECTRIC ARC FURNACE - WET

	No. of Plants	% of Total No of Plants	Daily Capacity of Plants (Tons)	% of Total Daily Capacity
Plants sampled for original study	2	20.0	2660	15.7
Plants sampled for toxic pollutant study	3 incl. 1 above	30.0 incl. 10.0 above	7500 incl. 1100 above	44.3 incl. 6.5 above
Total plants sampled	4	40.0	9060	53.5
Plants responding via D-DCP	3 incl. 2 above	40.0 incl. 20.0 above	9560 incl. 7060 above	56.5 incl. 41.7 above
Plants sampled and/or responding via D-DCP	5	60.0	11,560	68.3
Plants responding to DCP	9	100.0	16,933	100.0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COAL
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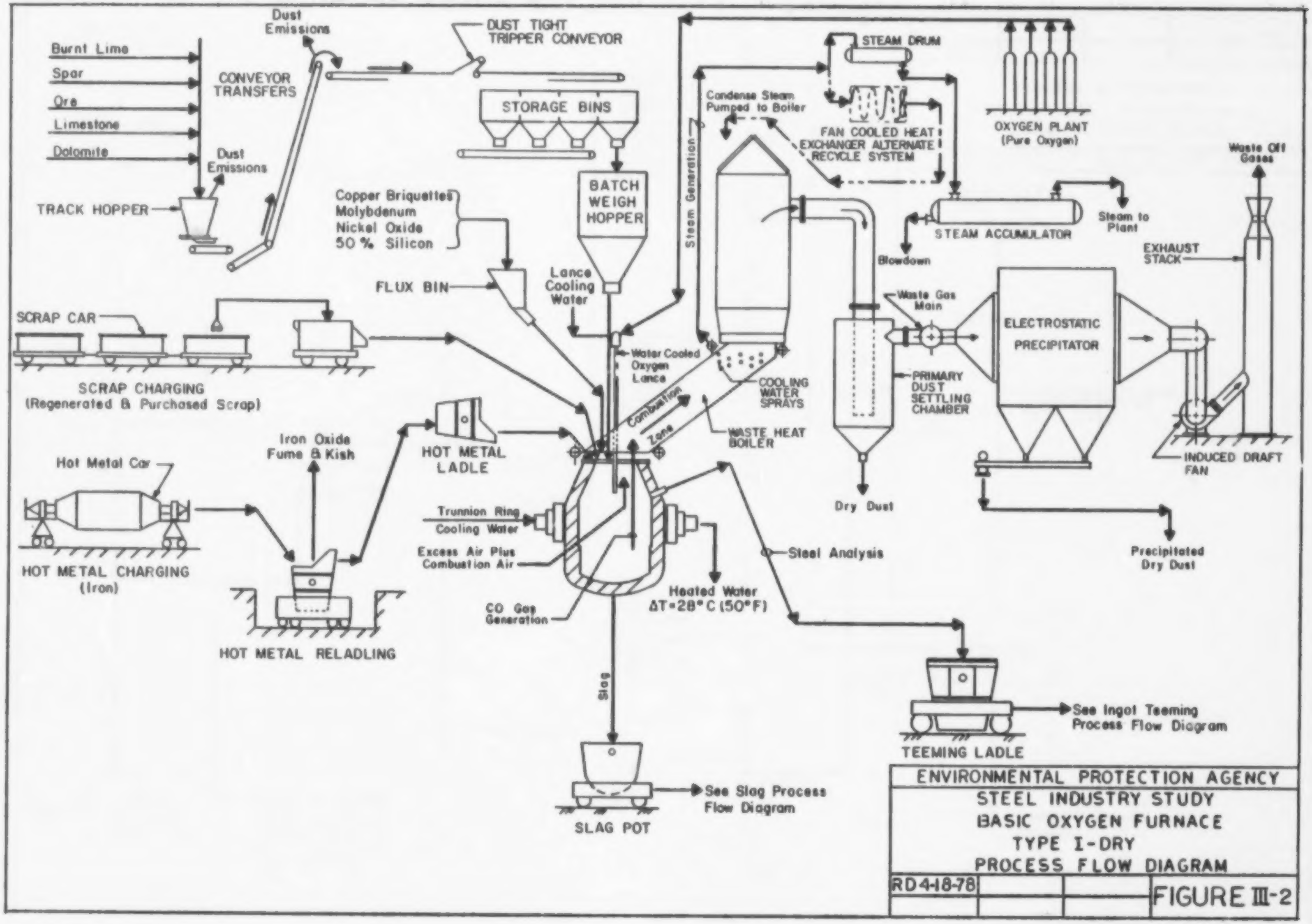
COKE
GAS & LIQUID
COAL CHEMICAL RECOVERY
COAL DISTILLATION PRODUCTS
AIR
ORE FINES
STONE FINES
COAL FINES
SINTER PLANT
SINTER
COKE
ORE
STONE
AIR
BLAST FURNACE
SLAG
HOT METAL
IRON
OXYGEN PLANT
OXYGEN
AIR
SCRAP
FLUX
IRON
BOF
SLAG
AIR
SCRAP
FLUX
IRON
OPEN HEARTH
SLAG
ELECTRODES
AIR
SCRAP
FLUX
IRON
ELECTRIC FURNACE
SLAG
LIQUID STEEL
LIQUID STEEL
LIQUID STEEL
LIQUID STEEL
CASTING
INGOTS
CAST STEEL INTERMEDIATES
MACHINING
FINISHED CAST STEEL PRODUCTS
Dwn. 5/8/79

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
STEEL PRODUCT MANUFACTURING
PROCESS FLOW DIAGRAM

FIGURE III-1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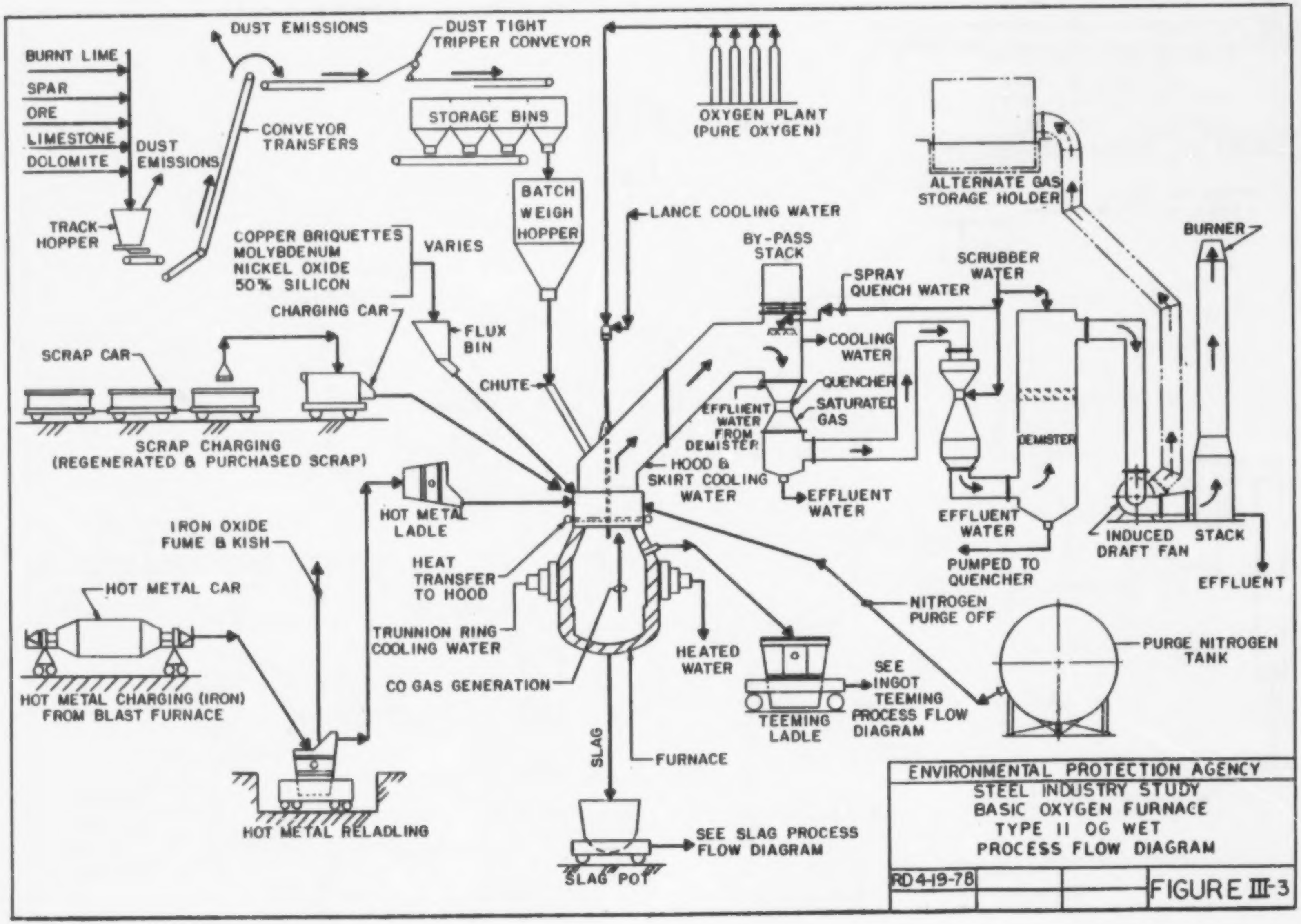
Spar
Ore
Limestone
Dolomite
TRACK HOPPER
Dust Emissions
CONVEYOR TRANSFERS
Dust Emissions
DUST TIGHT TRIPPER CONVEYOR
STORAGE BINS
BATCH WEIGH HOPPER
Copper Briquettes
Molybdenum
Nickel Oxide
50 % Silicon
FLUX BIN
Lance Cooling Water
SCRAP CAR
SCRAP CHARGING
(Regenerated & Purchased Scrap)
Water Cooled Oxygen Lance
Combustion Zone
Iron Oxide Fume & Kish
HOT METAL LADLE
Hot Metal Car
HOT METAL CHARGING
(Iron)
HOT METAL RELADLING
Trunnion Ring Cooling Water
Excess Air Plus Combustion Air
CO Gas Generation
Heated Water
ΔT=28°C (50°F)
Slag
SLAG POT
See Slag Process Flow Diagram
Steel Analysis
TEEMING LADLE
See Ingot Teeming Process Flow Diagram
Steam Generation
Condense Steam Pumped to Boiler
STEAM DRUM
FAN COOLED HEAT EXCHANGER ALTERNATE RECYCLE SYSTEM
OXYGEN PLANT
(Pure Oxygen)
STEAM ACCUMULATOR
Steam to Plant
Blowdown
COOLING WATER SPRAYS
WASTE HEAT BOILER
Waste Gas Main
PRIMARY DUST SETTLING CHAMBER
Dry Dust
ELECTROSTATIC PRECIPITATOR
Precipitated Dry Dust
EXHAUST STACK
Waste Off Gases
INDUCED DRAFT FAN

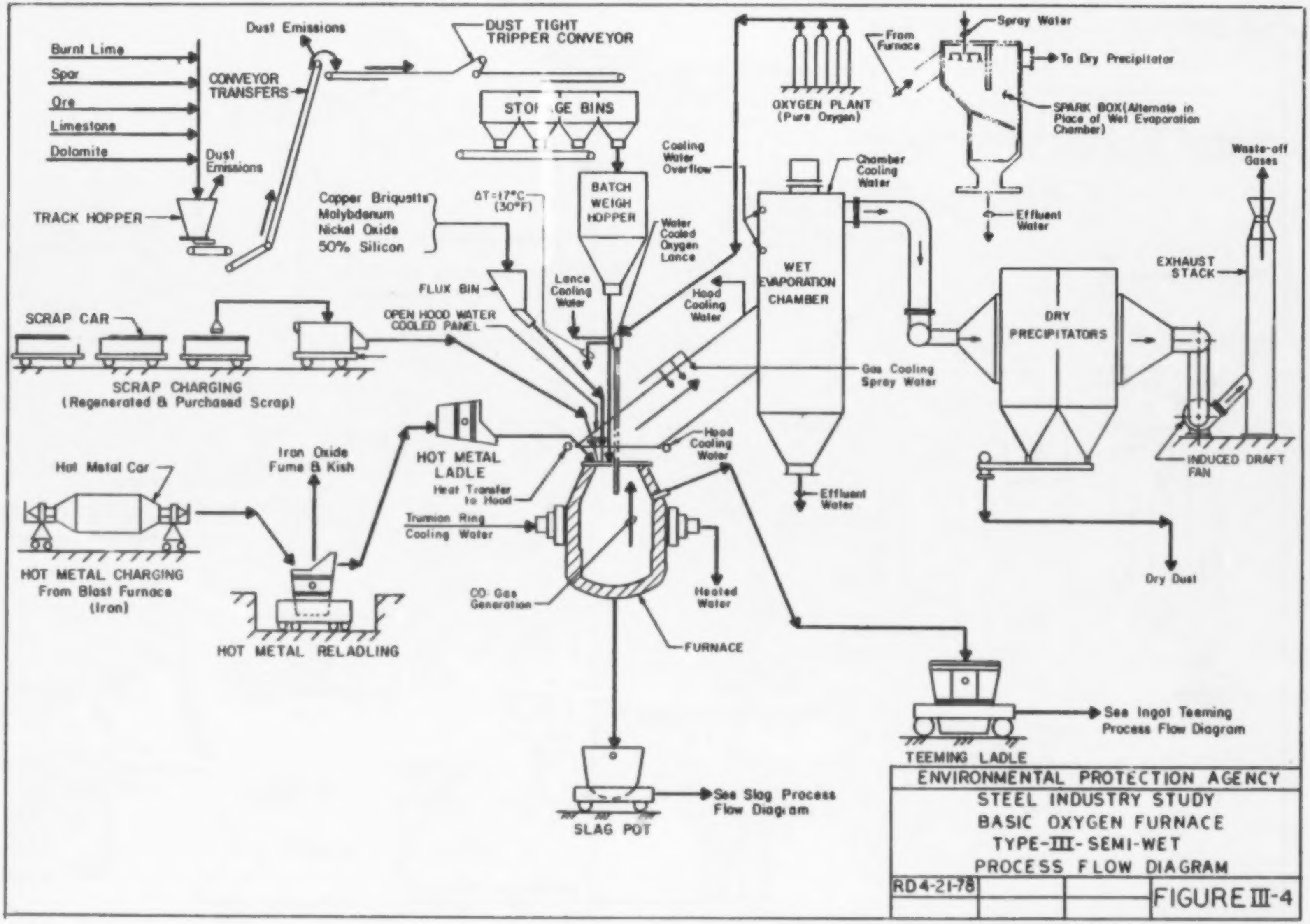
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
TYPE I-DRY
PROCESS FLOW DIAGRAM
RD 4-18-78
FIGURE III-2


DUST EMISSIONS
DUST TIGHT TRIPPER CONVEYOR
BURNT LIME
SPAR
ORE
LIMESTONE
DOLOMITE
DUST EMISSIONS
CONVEYOR TRANSFERS
STORAGE BINS
OXYGEN PLANT (PURE OXYGEN)
ALTERNATE GAS STORAGE HOLDER
TRACK HOPPER
BATCH WEIGH HOPPER
LANCE COOLING WATER
COPPER BRIQUETTES
MOLYBDENUM
NICKEL OXIDE
50% SILICON
VARIES
BY-PASS STACK
BURNER
SCRUBBER WATER
SPRAY QUENCH WATER
CHARGING CAR
FLUX BIN
SCRAP CAR
COOLING WATER
CHUTE
QUENCHER
SATURATED GAS
EFFLUENT WATER FROM DEMISTER
DEMISTER
SCRAP CHARGING (REGENERATED & PURCHASED SCRAP)
HOOD & SKIRT COOLING WATER
EFFLUENT WATER
HOT METAL LADLE
EFFLUENT WATER
INDUCED DRAFT FAN
STACK
IRON OXIDE FUME & KISH
PUMPED TO QUENCHER
EFFLUENT
HEAT TRANSFER TO HOOD
NITROGEN PURGE OFF
HOT METAL CAR
TRUNNION RING COOLING WATER
HEATED WATER
PURGE NITROGEN TANK
CO GAS GENERATION
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
HOT METAL CHARGING (IRON) FROM BLAST FURNACE
TEEMING LADLE
SLAG
FURNACE
HOT METAL RELADLING
SEE SLAG PROCESS FLOW DIAGRAM
SLAG POT

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
TYPE II OG WET
PROCESS FLOW DIAGRAM

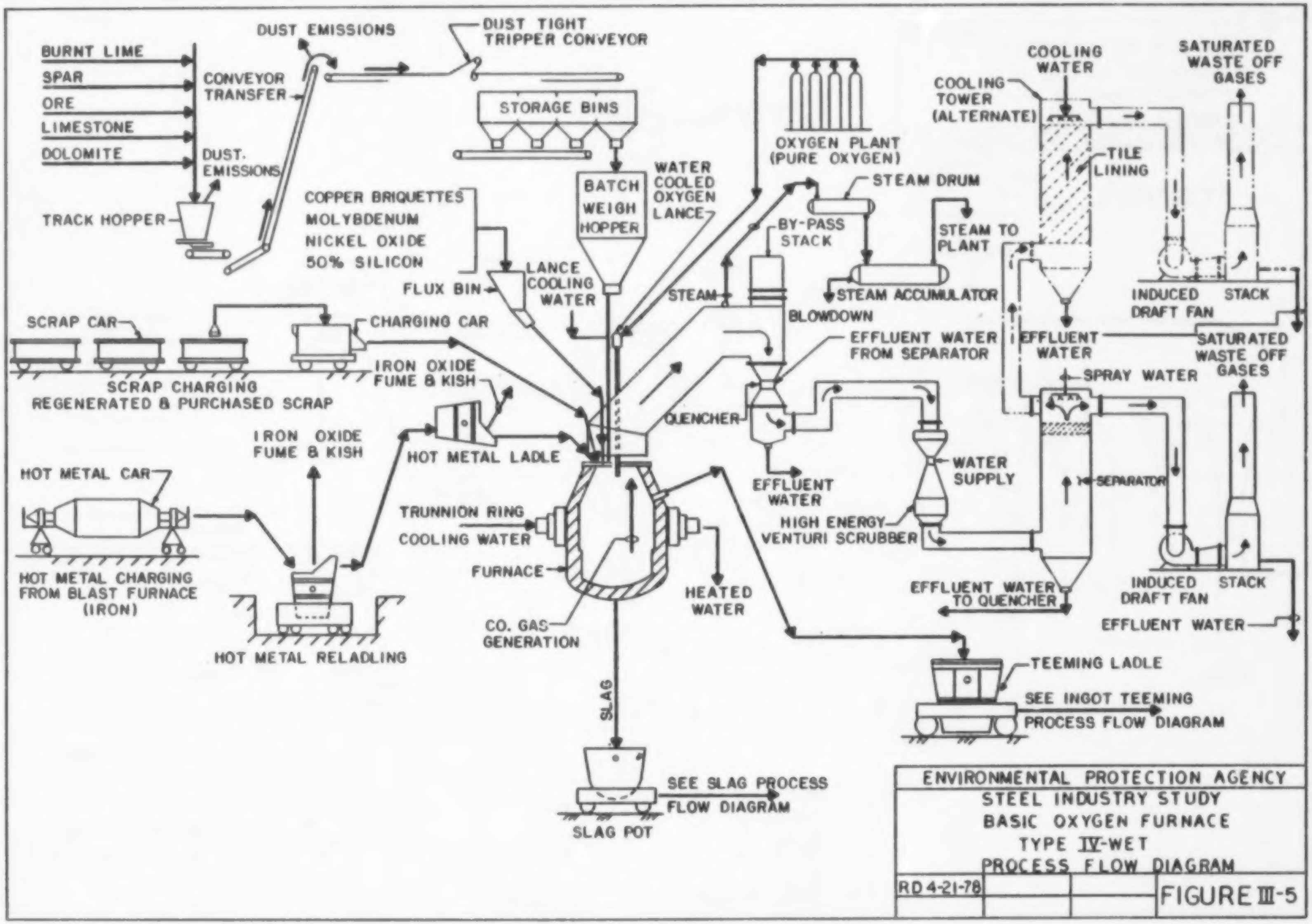
RD 4-19-78

FIGURE III-3


Burnt Lime
Spar
Ore
Limestone
Dolomite
TRACK HOPPER
Dust Emissions
CONVEYOR TRANSFERS
Dust Emissions
DUST TIGHT TRIPPER CONVEYOR
STORAGE BINS
BATCH WEIGH HOPPER
Copper Briquetts
Molybdenum
Nickel Oxide
50% Silicon
ΔT=17°C (30°F)
FLUX BIN
Lance Cooling Water
Water Cooled Oxygen Lance
OPEN HOOD WATER COOLED PANEL
SCRAP CAR
SCRAP CHARGING
(Regenerated & Purchased Scrap)
Hot Metal Car
HOT METAL CHARGING
From Blast Furnace
(Iron)
Iron Oxide Fume & Kish
HOT METAL RELADLING
HOT METAL LADLE
Heat Transfer to Hood
Trunion Ring Cooling Water
CO: Gas Generation
FURNACE
Heated Water
Hood Cooling Water
Hood Cooling Water
Cooling Water Overflow
OXYGEN PLANT
(Pure Oxygen)
From Furnace
Spray Water
To Dry Precipitator
SPARK BOX (Alternate in Place of Wet Evaporation Chamber)
Effluent Water
Chamber Cooling Water
WET EVAPORATION CHAMBER
Gas Cooling Spray Water
Effluent Water
DRY PRECIPITATORS
Dry Dust
EXHAUST STACK
Waste-off Gases
INDUCED DRAFT FAN
TEEMING LADLE
See Ingot Teeming Process Flow Diagram
SLAG POT
See Slag Process Flow Diagram
RD 4-21-78

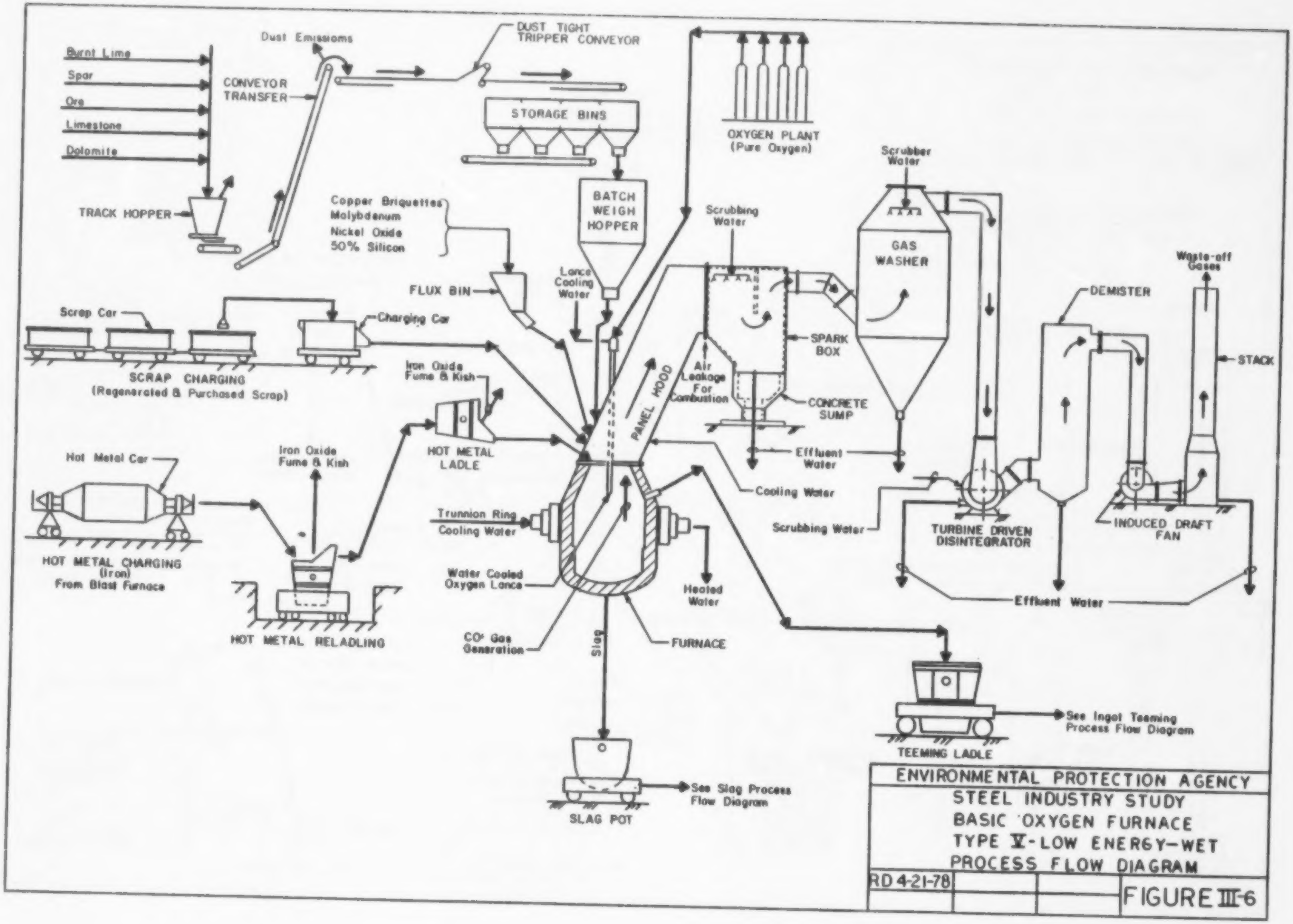
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
TYPE-III-SEMI-WET
PROCESS FLOW DIAGRAM

FIGURE III-4


BURNT LIME
SPAR
ORE
LIMESTONE
DOLOMITE
CONVEYOR TRANSFER
DUST. EMISSIONS
TRACK HOPPER
DUST EMISSIONS
DUST TIGHT TRIPPER CONVEYOR
STORAGE BINS
BATCH WEIGH HOPPER
WATER COOLED OXYGEN LANCE
COPPER BRIQUETTES
MOLYBDENUM
NICKEL OXIDE
50% SILICON
FLUX BIN
LANCE COOLING WATER
OXYGEN PLANT (PURE OXYGEN)
STEAM DRUM
BY-PASS STACK
STEAM TO PLANT
STEAM
STEAM ACCUMULATOR
BLOWDOWN
COOLING WATER
COOLING TOWER (ALTERNATE)
TILE LINING
SATURATED WASTE OFF GASES
INDUCED DRAFT FAN
STACK
EFFLUENT WATER
SATURATED WASTE OFF GASES
SCRAP CAR
CHARGING CAR
SCRAP CHARGING
REGENERATED & PURCHASED SCRAP
IRON OXIDE FUME & KISH
EFFLUENT WATER FROM SEPARATOR
SPRAY WATER
QUENCHER
IRON OXIDE FUME & KISH
HOT METAL LADLE
HOT METAL CAR
EFFLUENT WATER
WATER SUPPLY
SEPARATOR
TRUNNION RING
COOLING WATER
HIGH ENERGY VENTURI SCRUBBER
HOT METAL CHARGING FROM BLAST FURNACE (IRON)
FURNACE
HEATED WATER
INDUCED DRAFT FAN
STACK
EFFLUENT WATER TO QUENCHER
EFFLUENT WATER
CO. GAS GENERATION
HOT METAL RELADLING
TEEMING LADLE
SLAG
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
SEE SLAG PROCESS FLOW DIAGRAM
SLAG POT
RD 4-21-78

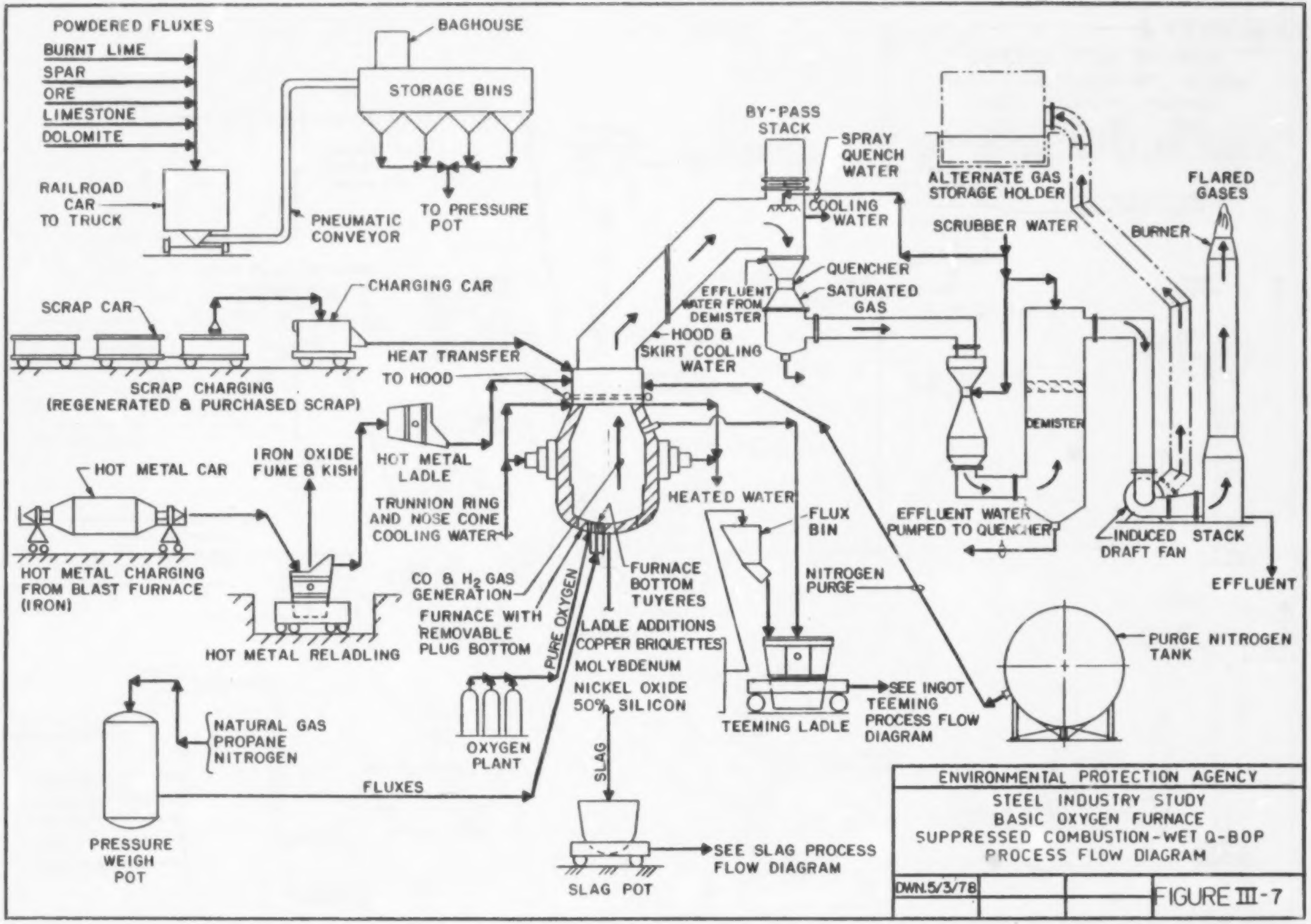
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
TYPE IV-WET
PROCESS FLOW DIAGRAM

FIGURE III-5

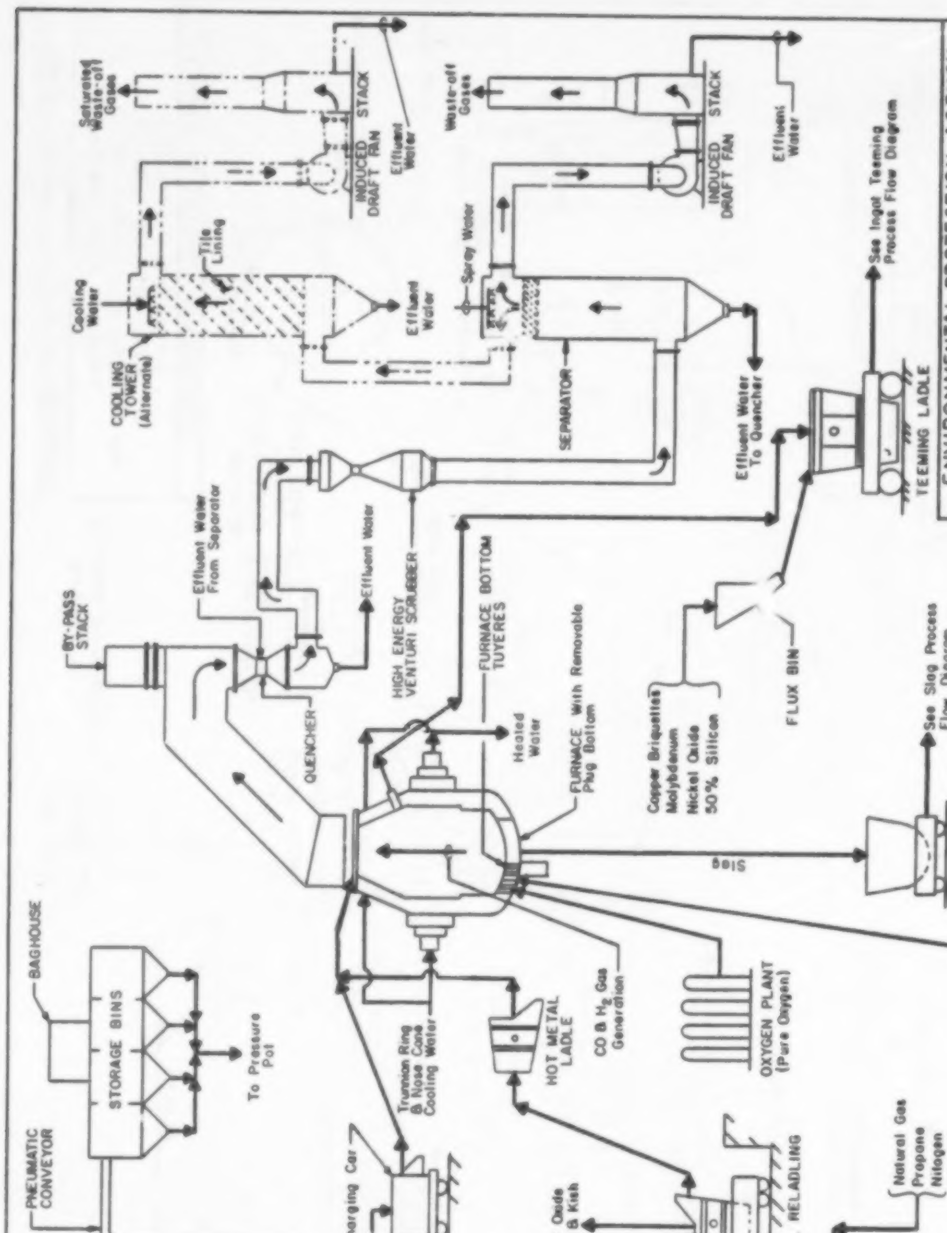

Burnt Lime
Spar
Ore
Limestone
Dolomite
TRACK HOPPER
CONVEYOR TRANSFER
Dust Emissioms
DUST TIGHT TRIPPER CONVEYOR
STORAGE BINS
BATCH WEIGH HOPPER
OXYGEN PLANT (Pure Oxygen)
Copper Briquettes
Molybdenum
Nickel Oxide
50% Silicon
FLUX BIN
Lance Cooling Water
Scrap Car
Charging Car
SCRAP CHARGING (Regenerated & Purchased Scrap)
Iron Oxide Fume & Kish
HOT METAL LADLE
Hot Metal Car
HOT METAL CHARGING (Iron) From Blast Furnace
Iron Oxide Fume & Kish
HOT METAL RELADLING
Trunnion Ring Cooling Water
Water Cooled Oxygen Lance
CO² Gas Generation
Slag
FURNACE
Heated Water
PANEL HOOD
Air Leakage For Combustion
Scrubbing Water
SPARK BOX
CONCRETE SUMP
Effluent Water
Cooling Water
Scrubber Water
GAS WASHER
Scrubbing Water
TURBINE DRIVEN DISINTEGRATOR
DEMISTER
INDUCED DRAFT FAN
Waste-off Gases
STACK
Effluent Water
TEEMING LADLE
See Ingot Teeming Process Flow Diagram
SLAG POT
See Slag Process Flow Diagram

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
TYPE V-LOW ENERGY-WET
PROCESS FLOW DIAGRAM
RD 4-21-78

FIGURE III-6


POWDERED FLUXES
BURNT LIME
SPAR
ORE
LIMESTONE
DOLOMITE
RAILROAD CAR TO TRUCK
BAGHOUSE
STORAGE BINS
TO PRESSURE POT
PNEUMATIC CONVEYOR
SCRAP CAR
CHARGING CAR
SCRAP CHARGING (REGENERATED & PURCHASED SCRAP)
HEAT TRANSFER
TO HOOD
HOT METAL CAR
HOT METAL CHARGING FROM BLAST FURNACE (IRON)
IRON OXIDE FUME & KISH
HOT METAL LADLE
HOT METAL RELADLING
TRUNNION RING AND NOSE CONE COOLING WATER
CO & H2 GAS GENERATION
FURNACE WITH REMOVABLE PLUG BOTTOM
PURE OXYGEN
OXYGEN PLANT
NATURAL GAS
PROPANE
NITROGEN
FLUXES
PRESSURE WEIGH POT
FURNACE BOTTOM TUYERES
LADLE ADDITIONS
COPPER BRIQUETTES
MOLYBDENUM
NICKEL OXIDE
50% SILICON
SLAG
SLAG POT
SEE SLAG PROCESS FLOW DIAGRAM
BY-PASS STACK
SPRAY QUENCH WATER
COOLING WATER
QUENCHER
SATURATED GAS
EFFLUENT WATER FROM DEMISTER
HOOD & SKIRT COOLING WATER
HEATED WATER
FLUX BIN
NITROGEN PURGE
TEEMING LADLE
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
SCRUBBER WATER
DEMISTER
EFFLUENT WATER PUMPED TO QUENCHER
ALTERNATE GAS STORAGE HOLDER
BURNER
FLARED GASES
INDUCED DRAFT FAN
STACK
EFFLUENT
PURGE NITROGEN TANK
DWN.5/3/78

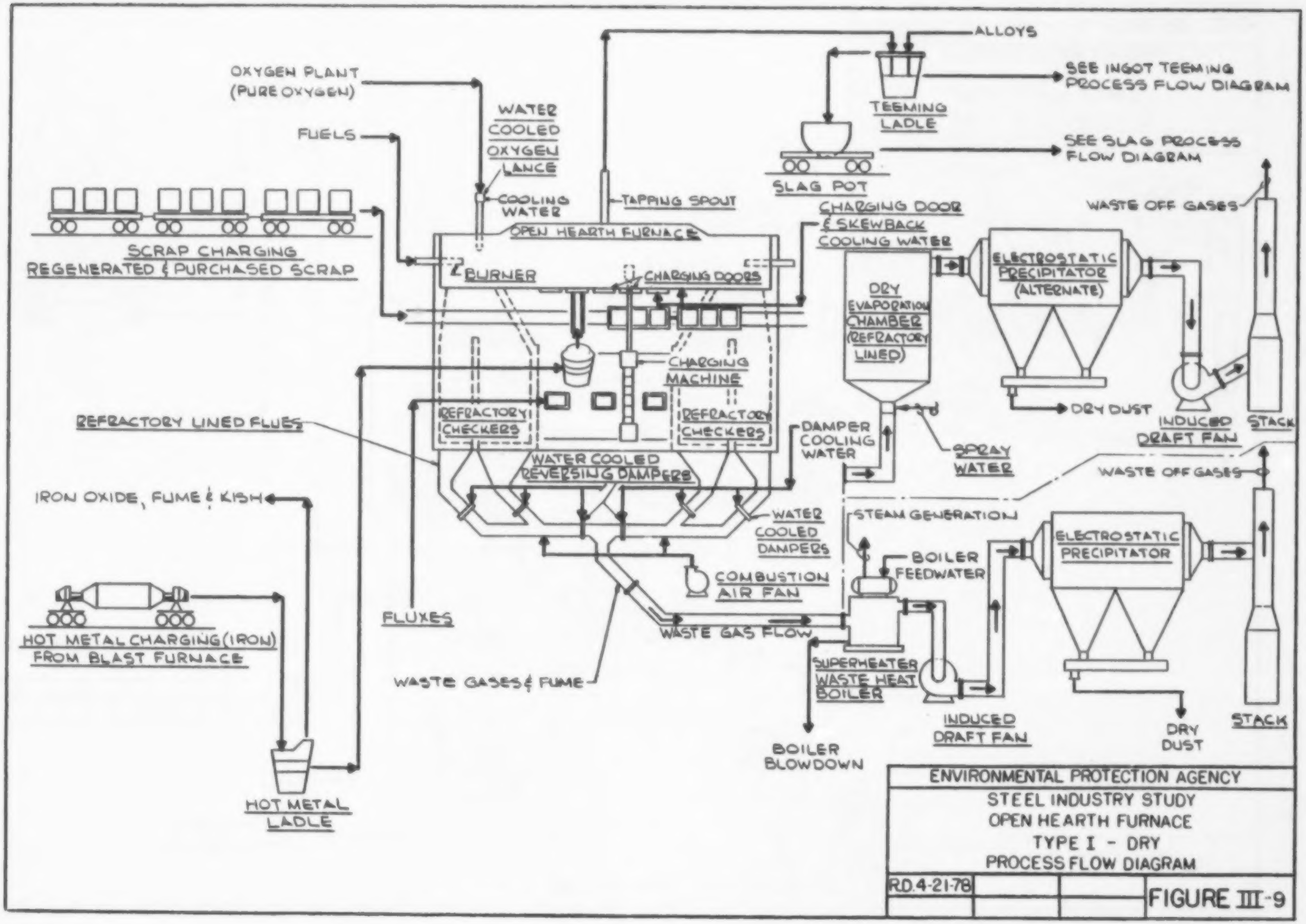
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
SUPPRESSED COMBUSTION-WET Q-BOP
PROCESS FLOW DIAGRAM
FIGURE III-7


Burnt Lime
Spar
Ore
Limestone
Dolomite
RAILROAD HOPPER CAR OR TRUCK
PNEUMATIC CONVEYOR
STORAGE BINS
BAGHOUSE
To Pressure Pot
Scrap Car
SCRAP CHARGING (Regenerated & Purchased Scrap)
Charging Car
Trunnion Ring & Nose Cone Cooling Water
Hot Metal Car
HOT METAL CHARGING (Iron) (From Blast Furnace)
Iron Oxide Fume & Kish
HOT METAL RELADLING
HOT METAL LADLE
CO & H2 Gas Generation
OXYGEN PLANT (Pure Oxygen)
PRESSURE WEIGH POT
Natural Gas
Propane
Nitrogen
Fluxes
Slag
SLAG POT
See Slag Process Flow Diagram
FURNACE With Removable Plug Bottom
Heated Water
Copper Briquettes
Molybdenum
Nickel Oxide
50% Silicon
FLUX BIN
FURNACE BOTTOM TUYERES
HIGH ENERGY VENTURI SCRUBBER
QUENCHER
BY-PASS STACK
Effluent Water From Separator
Effluent Water
Effluent Water To Quencher
TEEMING LADLE
See Ingot Teeming Process Flow Diagram
SEPARATOR
Spray Water
COOLING TOWER (Alternate)
Cooling Water
Tile Lining
Effluent Water
INDUCED DRAFT FAN
STACK
Saturated Waste-off Gases
Effluent Water
INDUCED DRAFT FAN
STACK
Waste-off Gases
Effluent Water

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
OPEN COMBUSTION-WET-Q-BOP
PROCESS FLOW DIAGRAM

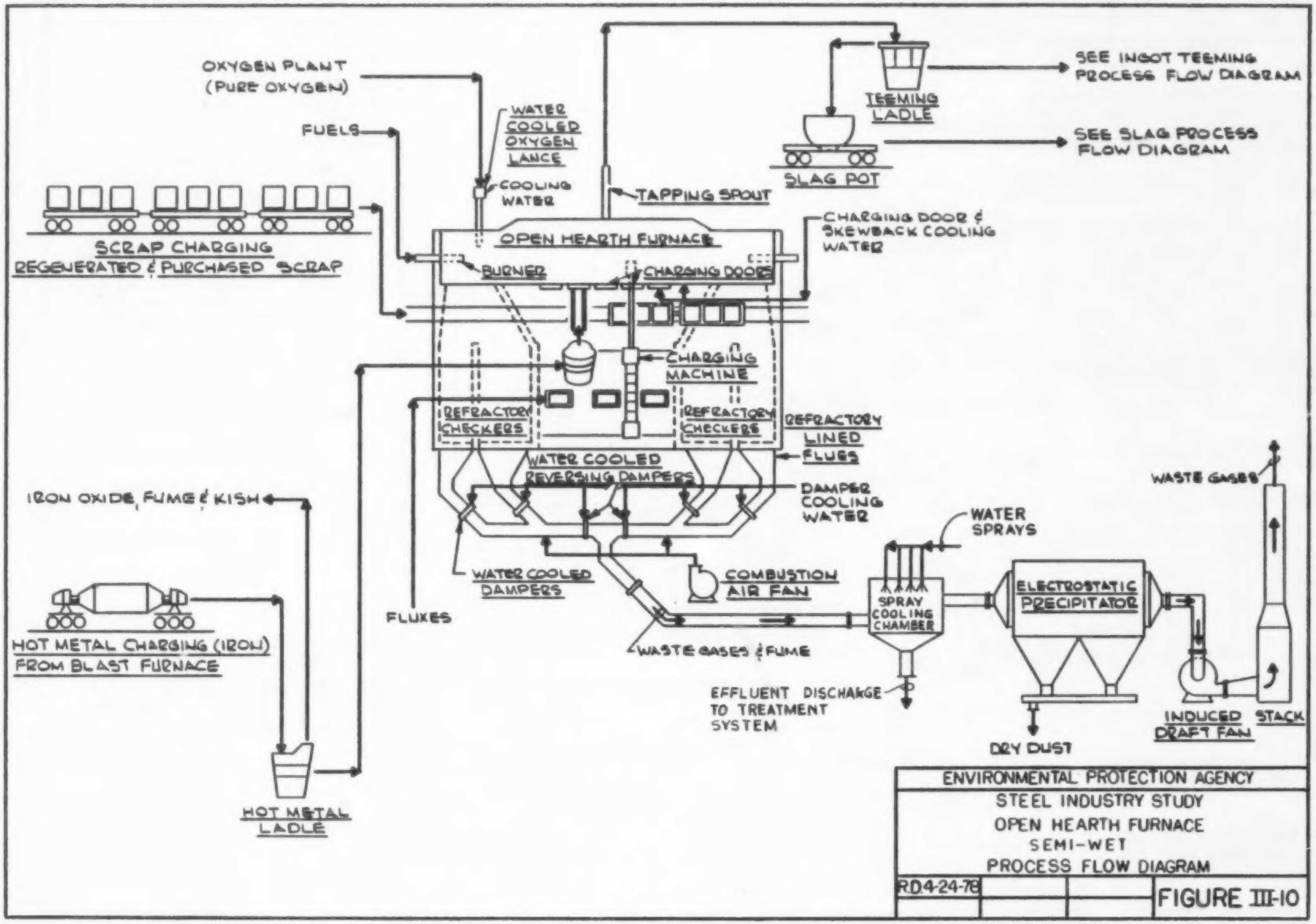
RD 5-2-78

FIGURE III-8


ALLOYS
OXYGEN PLANT (PURE OXYGEN)
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
TEEMING LADLE
WATER COOLED OXYGEN LANCE
FUELS
SEE SLAG PROCESS FLOW DIAGRAM
SLAG POT
COOLING WATER
TAPPING SPOUT
CHARGING DOOR & SKEWBACK COOLING WATER
WASTE OFF GASES
OPEN HEARTH FURNACE
SCRAP CHARGING
REGENERATED & PURCHASED SCRAP
BURNER
CHARGING DOORS
DRY EVAPORATION CHAMBER (REFRACTORY LINED)
ELECTROSTATIC PRECIPITATOR (ALTERNATE)
CHARGING MACHINE
REFRACTORY LINED FLUES
REFRACTORY CHECKERS
REFRACTORY CHECKERS
DRY DUST
INDUCED DRAFT FAN
STACK
DAMPER COOLING WATER
SPRAY WATER
WATER COOLED REVERSING DAMPERS
WASTE OFF GASES
IRON OXIDE, FUME & KISH
WATER COOLED DAMPERS
STEAM GENERATION
ELECTROSTATIC PRECIPITATOR
BOILER FEEDWATER
COMBUSTION AIR FAN
HOT METAL CHARGING (IRON) FROM BLAST FURNACE
FLUXES
WASTE GAS FLOW
SUPERHEATER WASTE HEAT BOILER
WASTE GASES & FUME
INDUCED DRAFT FAN
DRY DUST
STACK
BOILER BLOWDOWN
HOT METAL LADLE
RD.4-21-78

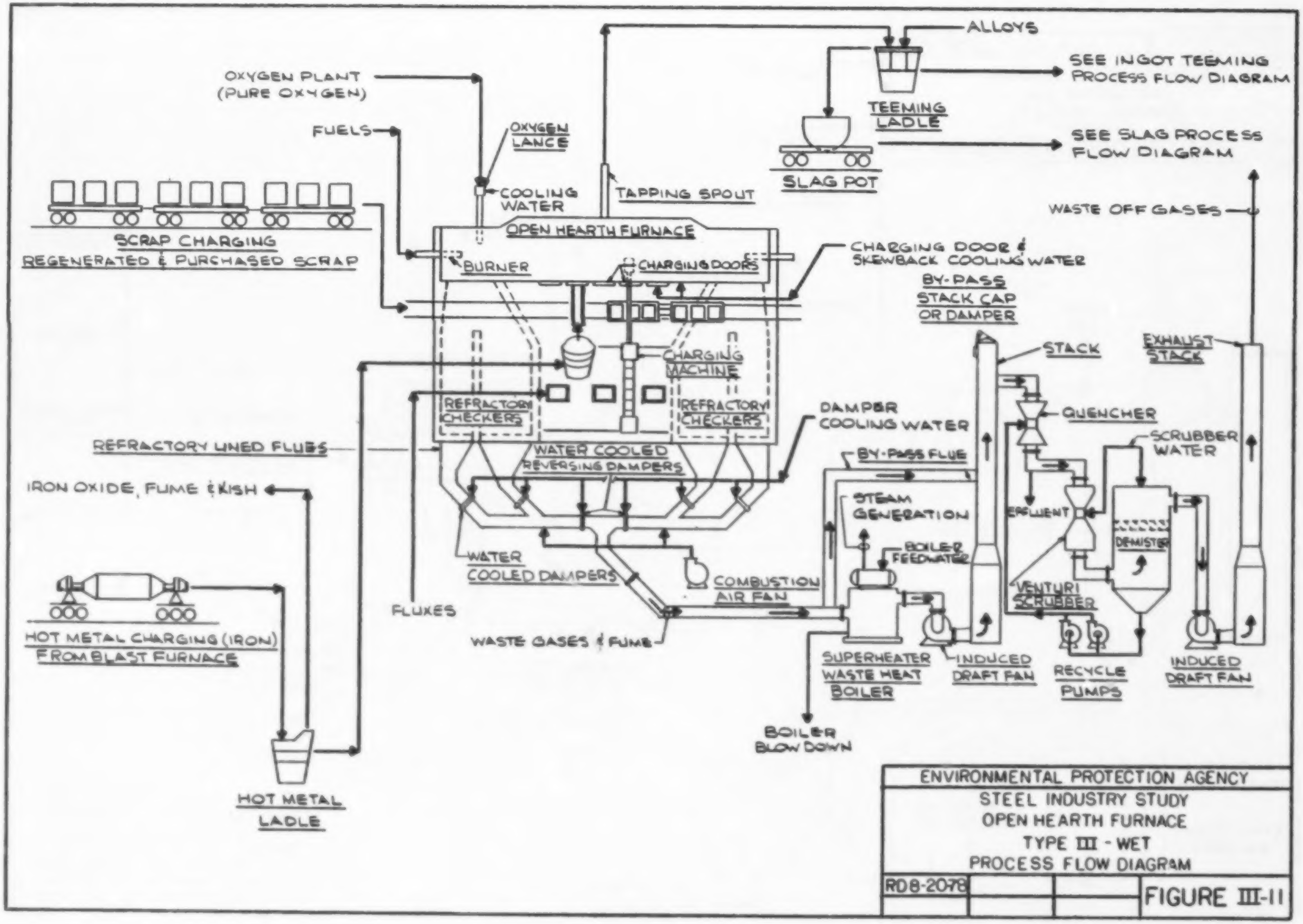
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
OPEN HEARTH FURNACE
TYPE I - DRY
PROCESS FLOW DIAGRAM

FIGURE III-9


OXYGEN PLANT
(PURE OXYGEN)
FUELS
WATER COOLED OXYGEN LANCE
COOLING WATER
TAPPING SPOUT
TEEMING LADLE
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
SLAG POT
SEE SLAG PROCESS FLOW DIAGRAM
SCRAP CHARGING
REGENERATED & PURCHASED SCRAP
OPEN HEARTH FURNACE
BURNER
CHARGING DOORS
CHARGING DOOR & SKEWBACK COOLING WATER
CHARGING MACHINE
REFRACTORY CHECKERS
REFRACTORY CHECKERS
REFRACTORY LINED FLUES
WATER COOLED REVERSING DAMPERS
DAMPER COOLING WATER
IRON OXIDE, FUME & KISH
WATER COOLED DAMPERS
COMBUSTION AIR FAN
WATER SPRAYS
SPRAY COOLING CHAMBER
ELECTROSTATIC PRECIPITATOR
WASTE GASES
STACK
INDUCED DRAFT FAN
DRY DUST
EFFLUENT DISCHARGE TO TREATMENT SYSTEM
WASTE GASES & FUME
FLUXES
HOT METAL CHARGING (IRON) FROM BLAST FURNACE
HOT METAL LADLE
R.D.4-24-78

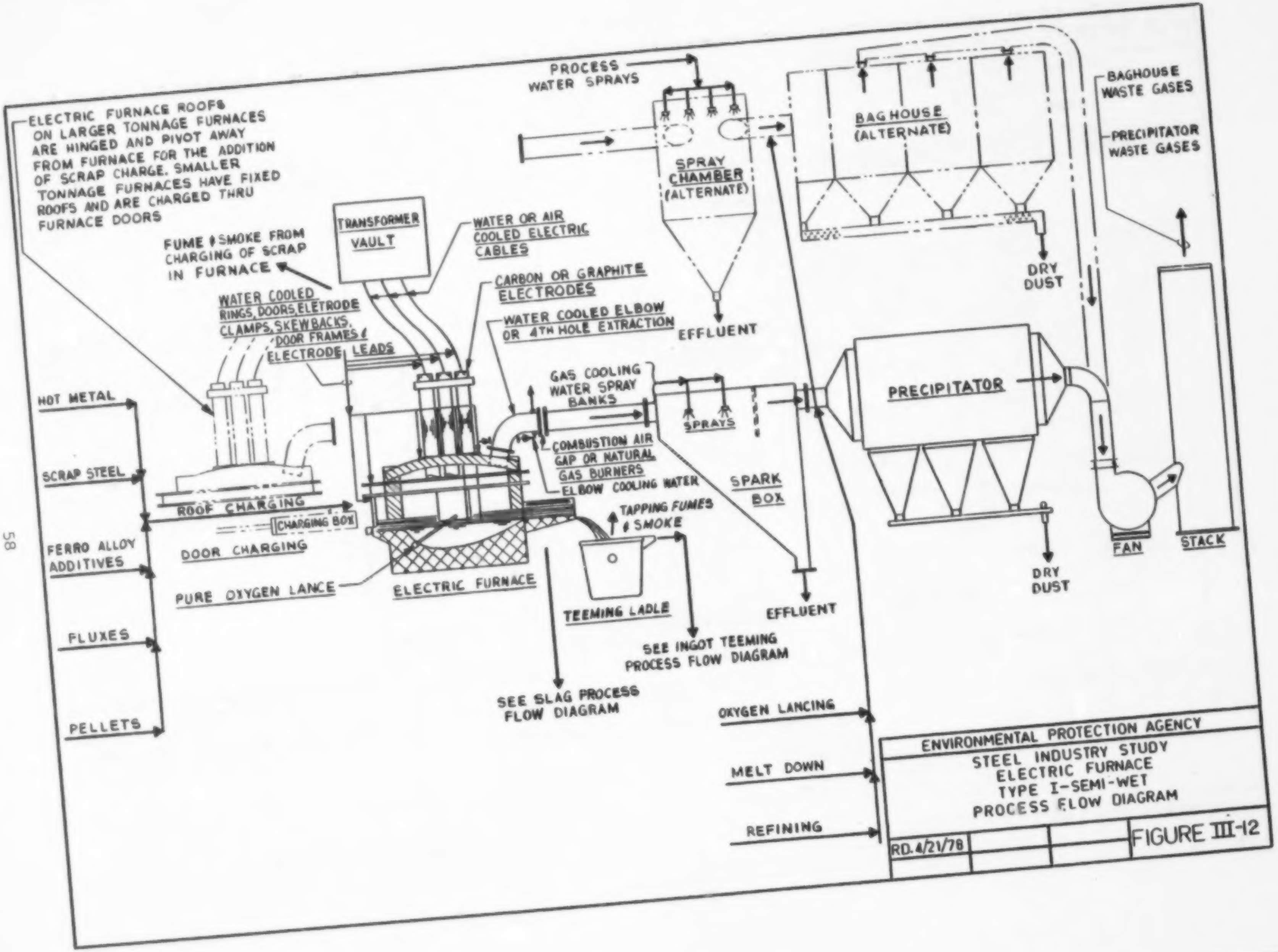
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
OPEN HEARTH FURNACE
SEMI-WET
PROCESS FLOW DIAGRAM

FIGURE III-10


ALLOYS
OXYGEN PLANT
(PURE OXYGEN)
TEEMING LADLE
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
FUELS
OXYGEN LANCE
SLAG POT
SEE SLAG PROCESS FLOW DIAGRAM
COOLING WATER
TAPPING SPOUT
WASTE OFF GASES
SCRAP CHARGING
REGENERATED & PURCHASED SCRAP
OPEN HEARTH FURNACE
BURNER
CHARGING DOORS
CHARGING DOOR & SKEWBACK COOLING WATER
BY-PASS STACK CAP OR DAMPER
STACK
EXHAUST STACK
CHARGING MACHINE
REFRACTORY CHECKERS
REFRACTORY CHECKERS
DAMPER COOLING WATER
QUENCHER
SCRUBBER WATER
REFRACTORY LINED FLUES
WATER COOLED REVERSING DAMPERS
BY-PASS FLUE
IRON OXIDE, FUME & KISH
STEAM GENERATION
EFFLUENT
BOILER FEEDWATER
DEMISTER
WATER COOLED DAMPERS
COMBUSTION AIR FAN
VENTURI SCRUBBER
HOT METAL CHARGING (IRON)
FROM BLAST FURNACE
FLUXES
WASTE GASES & FUME
SUPERHEATER WASTE HEAT BOILER
INDUCED DRAFT FAN
RECYCLE PUMPS
INDUCED DRAFT FAN
BOILER BLOW DOWN
HOT METAL LADLE

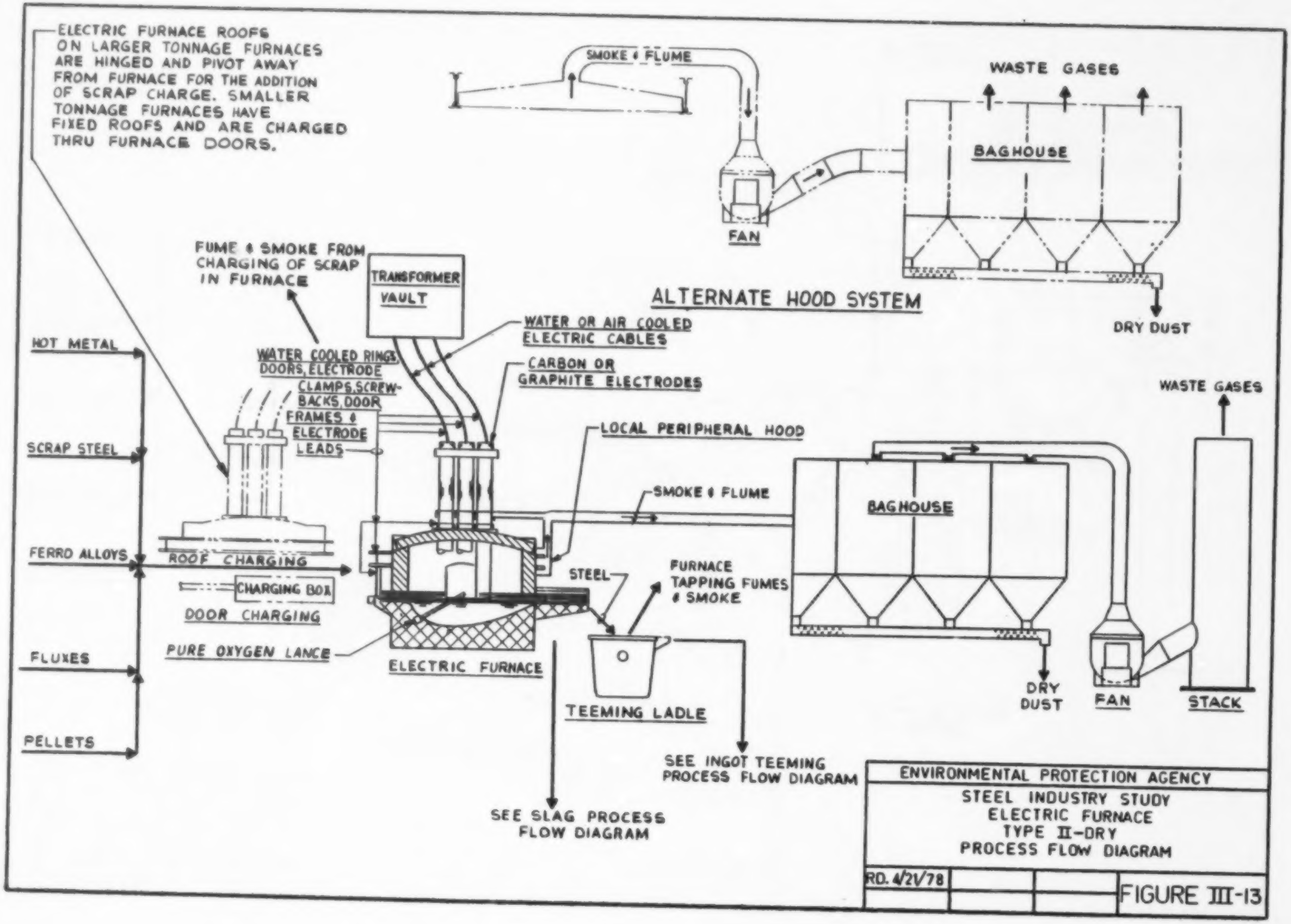
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
OPEN HEARTH FURNACE
TYPE III - WET
PROCESS FLOW DIAGRAM
RD8-2078

FIGURE III-11


ELECTRIC FURNACE ROOFS ON LARGER TONNAGE FURNACES ARE HINGED AND PIVOT AWAY FROM FURNACE FOR THE ADDITION OF SCRAP CHARGE. SMALLER TONNAGE FURNACES HAVE FIXED ROOFS AND ARE CHARGED THRU FURNACE DOORS
FUME & SMOKE FROM CHARGING OF SCRAP IN FURNACE
TRANSFORMER VAULT
WATER OR AIR COOLED ELECTRIC CABLES
CARBON OR GRAPHITE ELECTRODES
WATER COOLED ELBOW OR 4TH HOLE EXTRACTION
WATER COOLED RINGS, DOORS, ELETRODE CLAMPS, SKEWBACKS, DOOR FRAMES & ELECTRODE LEADS
PROCESS WATER SPRAYS
SPRAY CHAMBER (ALTERNATE)
EFFLUENT
BAGHOUSE (ALTERNATE)
DRY DUST
BAGHOUSE WASTE GASES
PRECIPITATOR WASTE GASES
HOT METAL
SCRAP STEEL
FERRO ALLOY ADDITIVES
FLUXES
PELLETS
ROOF CHARGING
CHARGING BOX
DOOR CHARGING
PURE OXYGEN LANCE
ELECTRIC FURNACE
GAS COOLING WATER SPRAY BANKS
COMBUSTION AIR GAP OR NATURAL GAS BURNERS
ELBOW COOLING WATER
TAPPING FUMES & SMOKE
TEEMING LADLE
SPRAYS
SPARK BOX
EFFLUENT
PRECIPITATOR
DRY DUST
FAN
STACK
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
SEE SLAG PROCESS FLOW DIAGRAM
OXYGEN LANCING
MELT DOWN
REFINING
RD. 4/21/78

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC FURNACE
TYPE I-SEMI-WET
PROCESS FLOW DIAGRAM

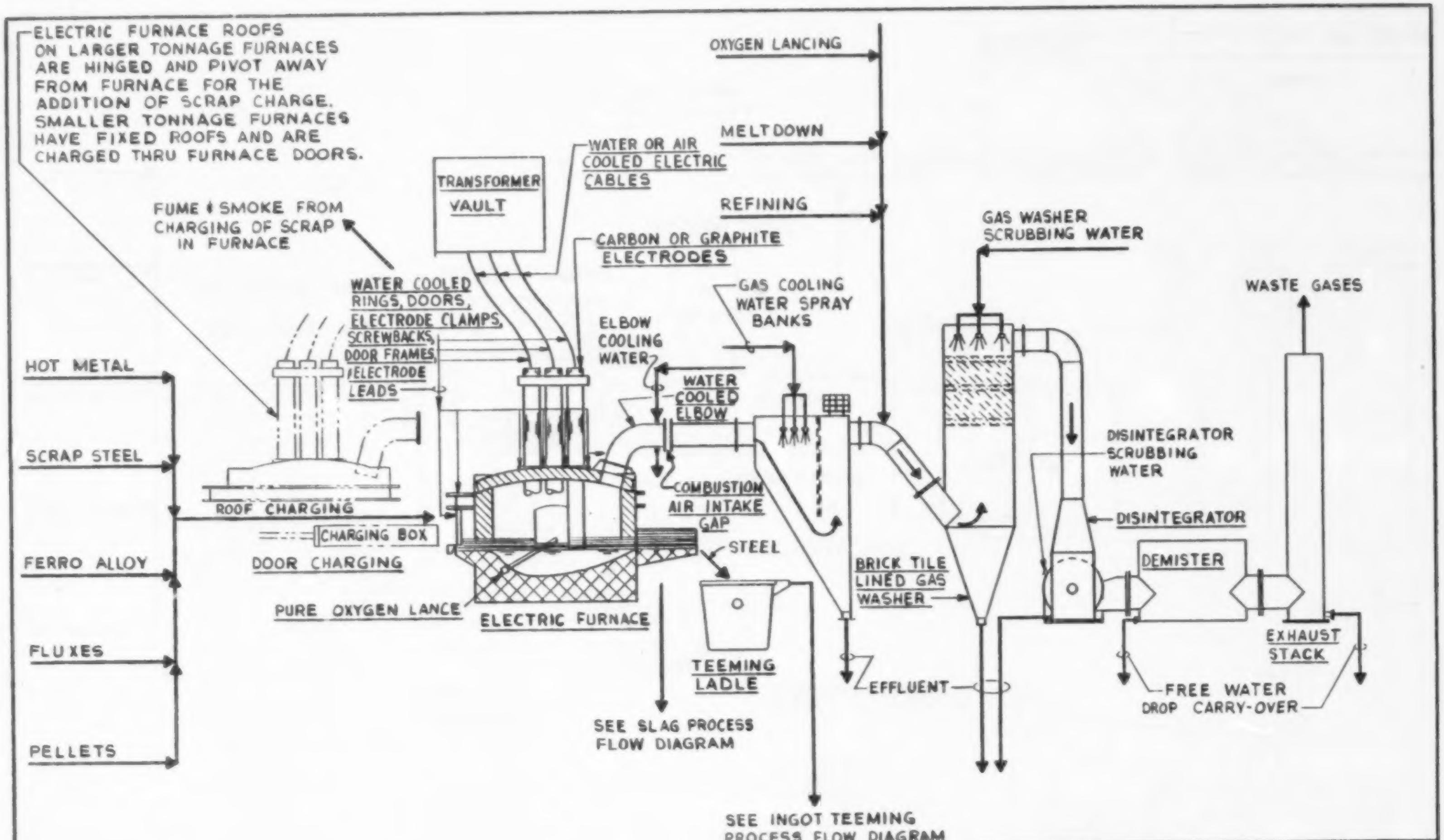
FIGURE III-12


ELECTRIC FURNACE ROOFS ON LARGER TONNAGE FURNACES ARE HINGED AND PIVOT AWAY FROM FURNACE FOR THE ADDITION OF SCRAP CHARGE. SMALLER TONNAGE FURNACES HAVE FIXED ROOFS AND ARE CHARGED THRU FURNACE DOORS.
SMOKE & FLUME
WASTE GASES
BAGHOUSE
FAN
ALTERNATE HOOD SYSTEM
DRY DUST
FUME & SMOKE FROM CHARGING OF SCRAP IN FURNACE
TRANSFORMER VAULT
WATER OR AIR COOLED ELECTRIC CABLES
CARBON OR GRAPHITE ELECTRODES
HOT METAL
WATER COOLED RINGS DOORS, ELECTRODE CLAMPS, SCREW-BACKS, DOOR FRAMES & ELECTRODE LEADS
WASTE GASES
LOCAL PERIPHERAL HOOD
SCRAP STEEL
SMOKE & FLUME
BAGHOUSE
FERRO ALLOYS
ROOF CHARGING
CHARGING BOX
DOOR CHARGING
STEEL
FURNACE TAPPING FUMES & SMOKE
FLUXES
PURE OXYGEN LANCE
ELECTRIC FURNACE
TEEMING LADLE
DRY DUST
FAN
STACK
PELLETS
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
SEE SLAG PROCESS FLOW DIAGRAM
RD. 4/21/78

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
ELECTRIC FURNACE
TYPE II-DRY
PROCESS FLOW DIAGRAM

FIGURE III-13

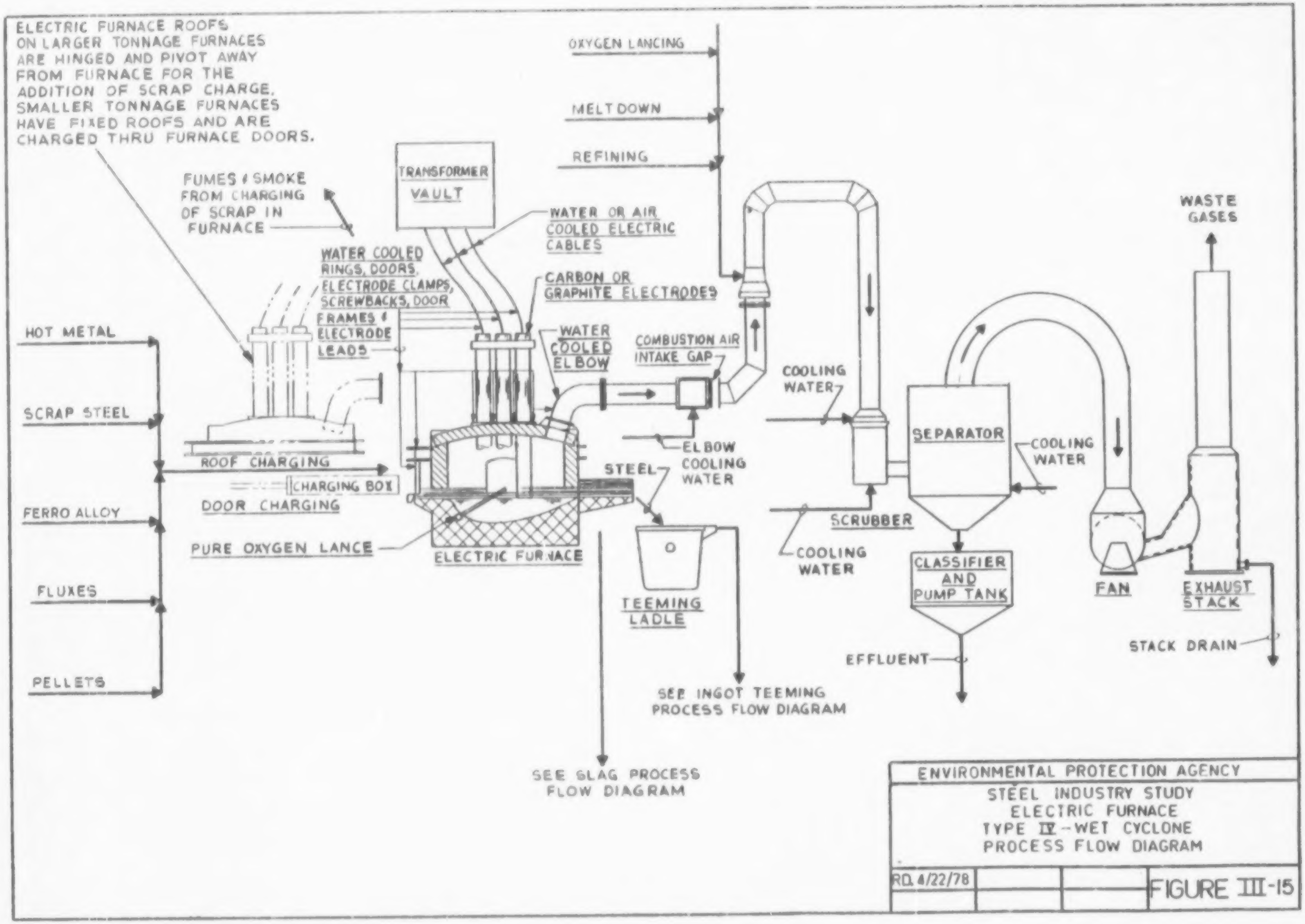

ELECTRIC FURNACE ROOFS ON LARGER TONNAGE FURNACES ARE HINGED AND PIVOT AWAY FROM FURNACE FOR THE ADDITION OF SCRAP CHARGE. SMALLER TONNAGE FURNACES HAVE FIXED ROOFS AND ARE CHARGED THRU FURNACE DOORS.
FUME & SMOKE FROM CHARGING OF SCRAP IN FURNACE
TRANSFORMER VAULT
WATER OR AIR COOLED ELECTRIC CABLES
CARBON OR GRAPHITE ELECTRODES
WATER COOLED RINGS, DOORS, ELECTRODE CLAMPS, SCREWBACKS, DOOR FRAMES, ELECTRODE LEADS
OXYGEN LANCING
MELTDOWN
REFINING
HOT METAL
SCRAP STEEL
FERRO ALLOY
FLUXES
PELLETS
ROOF CHARGING
CHARGING BOX
DOOR CHARGING
PURE OXYGEN LANCE
ELECTRIC FURNACE
ELBOW COOLING WATER
WATER COOLED ELBOW
COMBUSTION AIR INTAKE GAP
GAS COOLING WATER SPRAY BANKS
STEEL
TEEMING LADLE
SEE SLAG PROCESS FLOW DIAGRAM
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
GAS WASHER SCRUBBING WATER
BRICK TILE LINED GAS WASHER
EFFLUENT
DISINTEGRATOR SCRUBBING WATER
DISINTEGRATOR
DEMISTER
WASTE GASES
EXHAUST STACK
FREE WATER DROP CARRY-OVER

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
ELECTRIC FURNACE
TYPE III-WET WASHER
PROCESS FLOW DIAGRAM

RD. 4/24/78

FIGURE III-14


ELECTRIC FURNACE ROOFS ON LARGER TONNAGE FURNACES ARE HINGED AND PIVOT AWAY FROM FURNACE FOR THE ADDITION OF SCRAP CHARGE. SMALLER TONNAGE FURNACES HAVE FIXED ROOFS AND ARE CHARGED THRU FURNACE DOORS.
FUMES & SMOKE FROM CHARGING OF SCRAP IN FURNACE
TRANSFORMER VAULT
WATER OR AIR COOLED ELECTRIC CABLES
WATER COOLED RINGS, DOORS, ELECTRODE CLAMPS, SCREWBACKS, DOOR
FRAMES & ELECTRODE LEADS
CARBON OR GRAPHITE ELECTRODES
WATER COOLED ELBOW
COMBUSTION AIR INTAKE GAP
OXYGEN LANCING
MELTDOWN
REFINING
HOT METAL
SCRAP STEEL
FERRO ALLOY
FLUXES
PELLETS
ROOF CHARGING
CHARGING BOX
DOOR CHARGING
PURE OXYGEN LANCE
ELECTRIC FURNACE
STEEL
ELBOW COOLING WATER
TEEMING LADLE
SEE INGOT TEEMING PROCESS FLOW DIAGRAM
SEE SLAG PROCESS FLOW DIAGRAM
COOLING WATER
SCRUBBER
COOLING WATER
SEPARATOR
COOLING WATER
CLASSIFIER AND PUMP TANK
EFFLUENT
FAN
EXHAUST STACK
WASTE GASES
STACK DRAIN

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
ELECTRIC FURNACE
TYPE IV - WET CYCLONE
PROCESS FLOW DIAGRAM

RD. 4/22/78

FIGURE III-15

STEELMAKING SUBCATEGORY

SECTION IV

SUBCATEGORIZATION

Introduction

In reviewing the BPT effluent limitations originally promulgated in 1974, and in developing the proposed BPT, BAT, and BCT limitations and NSPS, PSES, and PSNS, the Agency evaluated the expanded data base to assure that the above limitations and standards sufficiently accommodated variations within the industry and each subdivision. Although basic oxygen furnace, open hearth furnace, and electric arc furnace remain as the major subdivisions within the steelmaking subcategory, the segments within these subdivisions were revised to provide a more accurate characterization of steelmaking operations. These revisions are based upon differences in wastewater characteristics and process water usage rates among the types of air pollution control systems in use. One of the revisions involved the development of suppressed and open combustion subsegments for the basic oxygen furnace wet air pollution control system segment. Also, a semi-wet air pollution control system segment was added to the open hearth furnace subdivision. The original and revised segments and subdivisions are presented below for the steelmaking subcategory.

Subcategories and Subdivisions (1974)	Revised Subdivisions and Segments
Basic Oxygen Furnace (BOF)	Basic Oxygen Furnace (BOF)
a. Semi-wet air pollution controls	a. Semi-wet air pollution controls
b. Wet air pollution controls	b. Wet air pollution controls - suppressed combustion
	c. Wet air pollution controls - open combustion
Open Hearth Furnace (OH)	Open Hearth Furnace (OH)
a. Wet air pollution controls	a. Semi-wet air pollution controls
	b. Wet air pollution controls
Electric Arc Furnace (EAF)	Electric Arc Furnace (EAF)
a. Semi-wet air pollution controls	a. Semi-wet air pollution controls
b. Wet air pollution controls	b. Wet air pollution controls

Although the Agency considered many factors in evaluating variations among and within the steelmaking subdivisions, all of the variations were related to the type of air pollution control system used. As a result, the segments within the steelmaking subdivisions reflect this observation.

Other factors considered in evaluating process differences include final product, raw material, size and age, and geographic location. The following discussions address these factors and substantiate the segments developed.

Factors Considered in the
Subdivision of the Steelmaking Subcategory

Manufacturing Process and Equipment

The principal element of steelmaking manufacturing processes and equipment, with regard to the development of effluent limitations, is the type of gas cleaning system. The systems normally employed are dry, semi-wet, and wet (see Section III). Since dry gas cleaning systems result in no wastewater or sludge discharge, only semi-wet and wet systems are addressed herein.

The semi-wet gas cleaning system uses a spark box chamber to reduce the furnace off-gas temperature prior to cleaning in precipitators or other dry dust collectors (i.e., baghouses). The gases are sprayed with water to insure proper temperature reduction so that they may be introduced to the dry collectors without causing damage. Most of the water applied to the spark box is evaporated, however, due to overspraying and the limited retention time involved, some water remains, eventually leaving as a wastewater discharge.

Wet gas cleaning systems, on the other hand, normally use Venturi scrubbers to remove particulates from the gas stream. Scrubber systems are used in both the open combustion and suppressed combustion methods of BOF gas collection. The open combustion method uses a gas collection hood, opened to the atmosphere, placed just above the BOF vessel. In contrast to open combustion, the hood in the suppressed combustion method is fitted to the BOF vessel and is closed to the atmosphere. The difference in gas collection methods results in differences in the quantity and quality of wastewater generated. The differences in the wastewaters generated by the various gas cleaning systems, and the rationale for these differences, is presented in the subsequent discussions regarding wastewater characteristics, wastewater treatability and process water usage.

The open hearth furnace and electric arc furnace steelmaking processes do not exhibit the variations in the types of wet air pollution control systems noted above for BOF operations. However, semi-wet air pollution control systems, as well as wet air pollution control systems, are used for both of these steelmaking processes.

No manufacturing processes or equipment, other than the type of gas cleaning system, affect the segmentation of the respective steelmaking subdivisions.

Final Products

As the final product of the various steelmaking operations is molten steel, segmentation on the basis of final product is not appropriate.

Raw Materials

While the raw materials for BOF, OH, and EAF operations may be somewhat different (different fluxes or scrap steel and molten iron charges), the Agency concluded that further segmentation of the steelmaking subdivisions, on the basis of raw materials, is not appropriate. It must be noted that the segments already noted sufficiently accommodate variations related to the raw materials.

A. BOF Steelmaking

BOF steelmaking operations can produce different steel compositions as a result of alloying. However, alloying is generally accomplished in the steel teeming ladle, so that the furnace product is similar. The only major difference in the steels lies in the carbon content which may vary somewhat, but remains less than 1%. However, the oxygen consumption rates (SCF/ton of steel) and, consequently, the off-gas volumes are approximately the same for the heats of steel regardless of the final carbon content in the finished steel.

A survey of all BOFs indicates that only one shop of the thirty-one wet discharge BOF shops in the United States can be classified as a specialty steel producer. A specialty steel shop produces less than 50% of its output as carbon steel while a carbon steel shop produces 50% or more of its output as carbon steel. The one specialty steel BOF shop was sampled as Plant 031, an open combustion system. Examination of the wastewater flow and analytical data for this plant, in comparison with other sampled open combustion plants, shows no significant variations. These data are presented in Tables VII-5 and VII-6. Based upon sample, DCP, and D-DCP data, BOF raw materials do not affect wastewater quality or quantity and thus were not used as a basis for segmentation.

B. Open Hearth Steelmaking

Although variations in scrap content affect wastewater quality, the type of scrap used in different open hearth furnaces is generally the same. Many different steel compositions can be produced, however, alloying is generally accomplished after the heat of steel is made. Alloys are added to the steel bath just before tapping, or to the ladle after tapping, and therefore, do not effect the gas cleaning systems in which the wastewaters originate.

A survey of all open hearth shops generating a wastewater indicates that none can be classified as a specialty steel producer. Therefore, all open hearth shops are considered carbon steel producers. Based upon sampled plant and DCP data, OH process raw materials do not affect wastewater quality and quantity to an appreciable extent and thus have not been used as a basis for segmentation.

C. Electric Arc Furnace Steelmaking

Raw materials, in the form of fluxes and cold scrap metal, are charged to electric arc furnaces. Similar types and quantities of fluxes are used in EAF steelmaking operations and thus do not vary significantly among the shops. Although variations in scrap could affect wastewater quality, as the types of scrap used in the different furnaces are approximately similar, the wastewaters are also similar.

Electric arc furnaces are generally used for the production of special alloy steels ranging from high strength low alloy steels to ferro-alloy products such as ferro-silicon and ferromanganese steels. Over 95% of the special alloy furnaces employ dry baghouse type systems, and thus have no wastewater discharges. There are currently nine EAF plants (ten shops) in the United States which have wet gas cleaning systems and three plants (three shops) which have semi-wet systems. Two plants (0060D and 0860H) which have wet gas cleaning systems are primarily specialty steel producers. While the remaining EAF shops produce primarily carbon steel, varying amounts of specialty steel are produced as well. The data obtained through the sampling visits, DCPs, and D-DCPs indicate little difference in wastewater quality and quantity between carbon and specialty shops. Hence, raw materials do not affect the segmentation of the electric arc furnace subdivision.

Wastewater Characteristics

As indicated in the discussion regarding manufacturing processes and equipment, the type of gas cleaning system used has a pronounced effect upon the quality of the wastewaters generated. The quantity of particulates captured in the wastewater and the size of the particulates vary with the type of gas cleaning system used.

A. BOF Steelmaking

Semi-wet system wastewaters are characterized by relatively small quantities of large suspended particulate matter. The difference between semi-wet and wet arise because of the design of the semi-wet water system versus that of the wet system. A semi-wet system is designed primarily to cool the hot gases in a spark box before they enter the dry precipitators in which the particulates are removed from the gas stream. However, due to the brief contact between water and the particulate laden gases, only a small portion of the particulate load, mainly the larger, slower moving particulates, is captured by the process waters. On the other hand, a wet scrubber system is specifically designed to remove the particulates from the gas stream with the result that higher concentrations of suspended matter are found in the process wastewaters. Following are the average suspended particulate concentrations for the raw wastewaters for each of the three BOF gas cleaning segments and subsegments.

Semi-Wet	375 mg/l
Wet-Suppressed Combustion	1500 mg/l
Wet-Open Combustion	4200 mg/l

The above data are based upon EPA surveys. The complete survey results are presented in Tables VII-2 through VII-6. A comparison of the semi-wet raw wastewater suspended solids level with the levels in the wet systems illustrates the point that semi-wet systems generate much lower raw wastewater suspended solids loads than wet systems.

The wastewater characteristics of a wet gas cleaning system differ with the type of gas collection method used (i.e., suppressed combustion or open combustion). The particulates emitted by an open combustion system will be primarily Fe_2O_3 due to the introduction of excess air to the system. Consequently, combustion is more complete and 90% of the particulates are of submicron size. Suppressed combustion, however, results in the formation of larger size particulates consisting of FeO and Fe_3O_4, as well as Fe_2O_3. Suppressed combustion systems provide incomplete combustion as only small quantities of outside air enter the system. As a result, only 30-40% of the particulates are of submicron size. In addition, the suppressed combustion configuration acts to contain the heavier particulates in the furnace with the result that wastewater suspended solids concentrations are lower (refer to the above data).

Therefore, based upon mechanical considerations and actual analytical data, wastewater characteristics substantiate the segmentation of the BOF subdivision into the semi-wet, wet-suppressed combustion, and wet-open combustion segments.

B. Open Hearth Steelmaking

The open hearth steelmaking process employs semi-wet and wet gas cleaning systems similar to those described above for the BOF steelmaking process. Following are the average raw wastewater suspended solids concentrations for each of these two gas cleaning systems.

Semi-wet	500 mg/l
Wet	1,100 mg/l

The Agency obtained the above data during its sampling surveys (see Tables VII-7 through VII-9). The comparison of the semi-wet raw wastewater suspended solids concentration with that of the wet system illustrates the point that semi-wet systems generate lower raw wastewater suspended solids concentrations than wet systems.

Based upon analytical data, the Agency believes that the segmentation of the open hearth subdivision into semi-wet and wet segments is appropriate.

C. Electric Arc Furnace Steelmaking

The electric arc furnace steelmaking process employs semi-wet and wet gas cleaning systems similar to those described previously for the BOF steelmaking process. Electrostatic precipitators or filter cloth baghouses are employed in the dry systems. Following are the average raw wastewater suspended solids concentrations for each of the two types of gas cleaning systems.

Semi-wet	2,200 mg/l
Wet	3,400 mg/l

The Agency obtained the above data during its sampling surveys (see Tables VII-10 through VII-13). A comparison of the semi-wet raw wastewater suspended solids concentrations with the wet system concentrations illustrate the point that semi-wet systems result in a much lower raw wastewater TSS concentration than wet systems.

Based upon sampled plant data, the Agency believes it is appropriate to segment the electric arc furnace subdivision into semi-wet and wet segments based upon wastewater characteristics.

Wastewater Treatability

The treatability of wastewaters from each steelmaking operation is similar. The various steelmaking operations use similar treatment components and are thus able to achieve similar effluent qualities. The major treatment components used in these operations are gravity sedimentation devices and recycle systems. Coagulant aids are added at many plants to enhance suspended solids removals. Vacuum filters are used to dewater the sludges removed in the treatment process. Because of these similarities in the treatability of steelmaking process wastewaters, no further segmentation of the steelmaking subdivisions, based upon wastewater treatability, is required.

Size and Age

The Agency considered the impact of size and age on the segmentation of the steelmaking subdivisions. Possible correlations relating the effects of age and size upon such elements as wastewater flow, wastewater characteristics and the ability to retrofit treatment equipment to existing facilities were analyzed. The Agency did not find any relationships and, thus, determined that size and age have no significant impact upon subdivision or segmentation.

Analysis of the data (refer to the Section III summary tables) failed to yield any correlations between the size of a steelmaking shop and any pertinent factors such as process water usage, wastewater characteristics, or effluent flow. Figures IV-1 through IV-6 illustrate the comparisons of effluent flow (gal/ton) vs. shop size (tons/day capacity). No figure is provided for the open hearth - semi-wet subdivision as there is only one shop in this subdivision. These figures also depict treatment model sizes and effluent flows. Effluent flow conveniently reflects the installation of recycle and, thus, provides a representation of wastewater treatment. As can be seen on these plots, the size of a steelmaking shop does not significantly affect the ability to recycle and thus attain low effluent flows. A review of EPA survey data (refer to the tables in Section VII) also shows no relationship between shop size and the characteristics of the wastewaters generated. Therefore, the Agency concluded that it is not appropriate to further segment the steelmaking subdivisions based upon the size of a steelmaking shop.

The Agency examined the age of a shop as a possible basis for the segmentation of the steelmaking subdivisions. With regard to BOF shops, however, age has little meaning, as the BOF process is a relatively recent development. Referring to the data base (Section III summary tables), the oldest BOF now in operation was installed in 1955 while most were built in the 1960s. Hence, there is little variation in relative age among the BOF shops. The same consideration applies to the three open hearth-wet shops, as their first years of production fall within a period of six years. Following the same concepts used in comparing effluent flow and shop size, Figures IV-7 through IV-12 illustrate the relationship of effluent flow vs. shop age. As with the effluent flow and shop size plots, the age of a steelmaking shop was found to have no significant effect on the ability to recycle and thus attain a low effluent flow.

Further analysis indicates that the age of a steelmaking shop has no affect on the quality or quantity of wastewaters generated. Within the segments outlined by the different gas cleaning systems, older shops were found to generate wastewaters similar in quality and quantity to those of newer shops. Also the treatability of these wastewaters was found to be similar in all instances.

The Agency also addressed the problem of retrofitting water pollution control equipment as part of the shop age analysis. The ability to retrofit pollution control equipment has been demonstrated at many plants as shown in Tables IV-1 through IV- 3. These examples illustrate the fact that water pollution control equipment can be installed on existing plant facilities. In addition, the Agency analyzed the cost of retrofit to determine whether older plants incurred additional capital expenditures to install new water pollution control equipment. D-DCPs were used to solicit retrofit cost information. D-DCP responses for seven of thirteen steelmaking shops indicate that retrofit costs were not applicable as the wastewater treatment systems were installed in conjunction with the installation of the furnaces. In addition, the responses for four shops were inconclusive as retrofit costs were not available, included capital expenditures for pollution control equipment, or included components not related to the treatment of process wastewaters. However, the data provided for two shops (one open hearth and one electric arc furnace) indicate no retrofit costs were required. The above data indicate that older plants will incur and have incurred costs of equipment installation similar to that for newer plants. The retrofit issue as it pertains to industry-wide costs is addressed in Volume I.

Based upon the above, the Agency concludes that neither the size nor age of a steelmaking shop affects the ability to provide treatment for process wastewaters. Therefore, further segmentation of the steelmaking subdivisions based upon shop size or age is not appropriate.

Geographic Location

The Agency analyzed the relationships between location and pertinent factors such as wastewater usage, wastewater characteristics, and wastewater treatability. However, no discernible patterns were revealed. All BOF shops, with the exception of one, are located east of the Mississippi River and are concentrated in the steelmaking areas of Alabama, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and West Virgina. The remaining BOF shop, a semi-wet system, is located in Colorado. The open hearth furnace wet subdivision shops are located in Ohio, Texas, and Maryland, while the semi-wet subdivision shop is located in Utah. The electric arc furnace wet subdivision shops are located in Pennsylvania, Texas, Michigan, Illinois, and California, while the semi-wet subdivision shops are located in Ohio, Michigan, and Texas.

With regard to the consumptive use of water in "arid" and "semi-arid" regions, the geographic location of those steelmaking shops with wet gas cleaning systems is of no consequence since the model treatment system components would consume essentially no water. Therefore, the geographic location of a steelmaking shop does not require further segmentation of the steelmaking subdivisions.

Process Water Usage

Process water usage was a significant factor in establishing the segments of the steelmaking subdivisions. As noted previously in this section, the Agency found significant differences among and within the types of gas cleaning systems in use. The differences in process water flow support the segments developed previously in this section. However, in reviewing the process water usage data, the Agency concluded that further segmentation beyond those already established is not appropriate.

TABLE IV-1

EXAMPLES OF PLANTS WHICH HAVE DEMONSTRATED THE ABILITY TO RETROFIT POLLUTION CONTROL EQUIPMENT BASIC OXYGEN FURNACE SUBDIVISION

Plant Code	Furnace Age 1st Year of Production	Treatment Equipment and Year Installed
0112B	1964	Clarifier-1970
0248A	1968	Vacuum Filter-1973
0396D	1959	Primary Scale Pit, Polymer Addition, Clarifier, Vacuum Filter-1970
0432C	1961	Clarifiers and other equipment (Central Treatment) 1964, 1971
0584C	1968	Breakpoint Chlorination, Deep Bed Sand Filter, Dechlorination with SO_2, (Central Treatment)-1977
0724A	1962	Clarifier, Polymer Addition-1972
0860B	1965	Clarifier-1974 Surface Skimming, Lagoon-1970

TABLE IV-2

EXAMPLES OF PLANTS WHICH HAVE DEMONSTRATED THE ABILITY TO RETROFIT POLLUTION CONTROL EQUIPMENT OPEN HEARTH FURNACE SUBDIVISION

Plant Code	Furnace Age 1st Year of Production	Treatment Equipment and Year Installed
0060	1952	Clarifier, Neutralization with caustic-1970. Polymer Addition, Neutralization with Lime, Clarifier-1978
0112A	1957-1958	Thickener-1971
0492A	1953	Neutralization with Lime, Clarifier-1972.
0864A	1944	Polymer and Lime Additions, Clarifier, Thickener-1962 Clarifier-1969 Clarifier-1976
0948C	1952-1953	Screening, Thickeners-1967

TABLE IV-3

EXAMPLES OF PLANTS WHICH HAVE DEMONSTRATED THE ABILITY TO RETROFIT POLLUTION CONTROL EQUIPMENT ELECTRIC ARC FURNACE SUBDIVISION

Plant Code	Furnace Age 1st Year of Production	Treatment Equipment and Year Installed
0060D	1969	Chemical Reduction-1977
0060F	1951	Classifier, Clarifier, Vacuum Filter-1963
0432C	1959	Clarifiers and other equipment (Central Treatment) 1964, 1971
0528A	1949	Clarifiers and other equipment (Central Treatment) 1954

FIGURE IV-1

PLANT SIZE (PRODUCTION CAPACITY) vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE: SEMI-WET

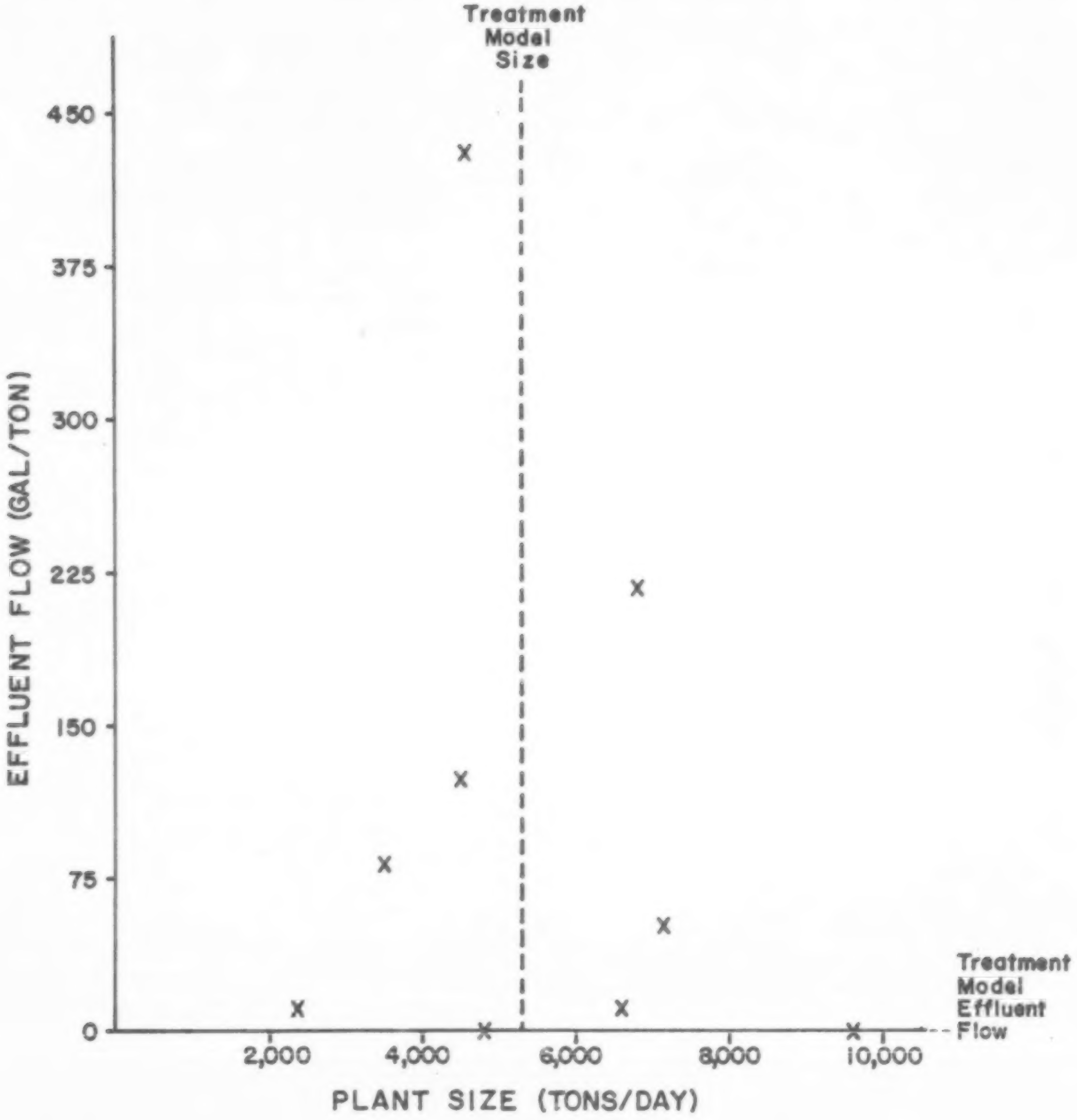


FIGURE IV-2

PLANT SIZE (PRODUCTION CAPACITY) vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE: WET - SUPPRESSED COMBUSTION

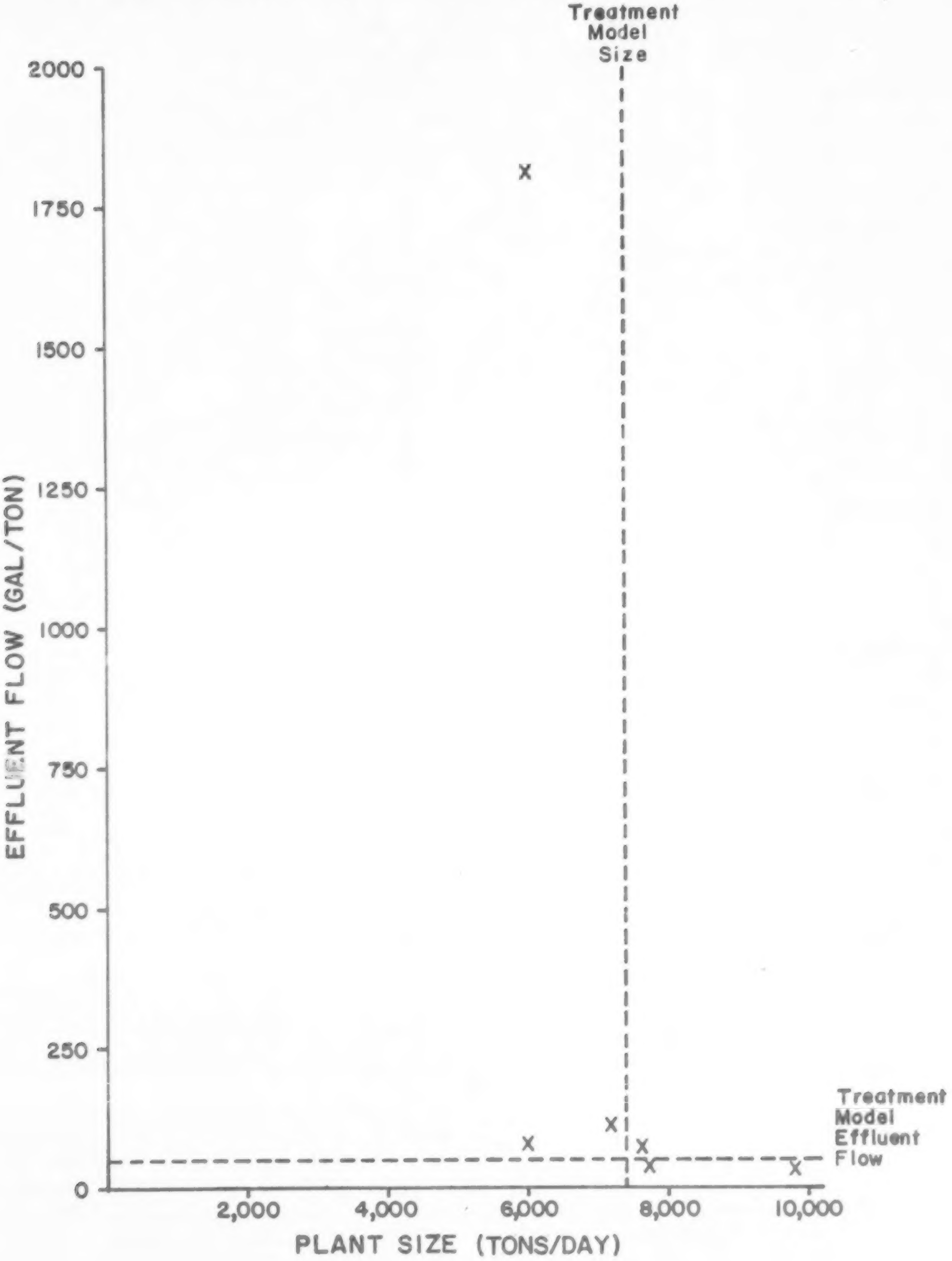


FIGURE IV-3

PLANT SIZE (PRODUCTION CAPACITY) vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE: WET-OPEN COMBUSTION

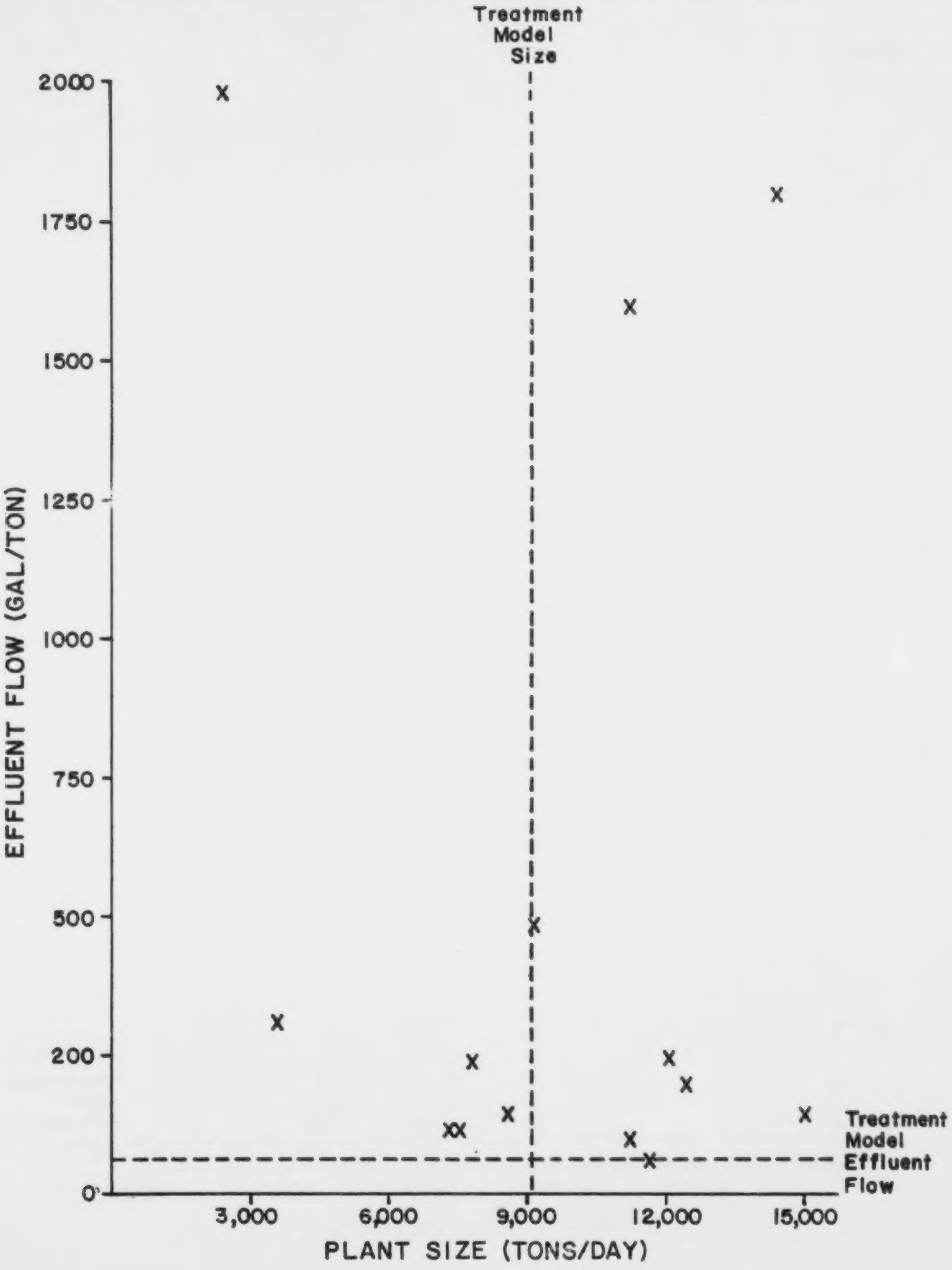


FIGURE IV-4

PLANT SIZE (PRODUCTION CAPACITY) vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACE: WET

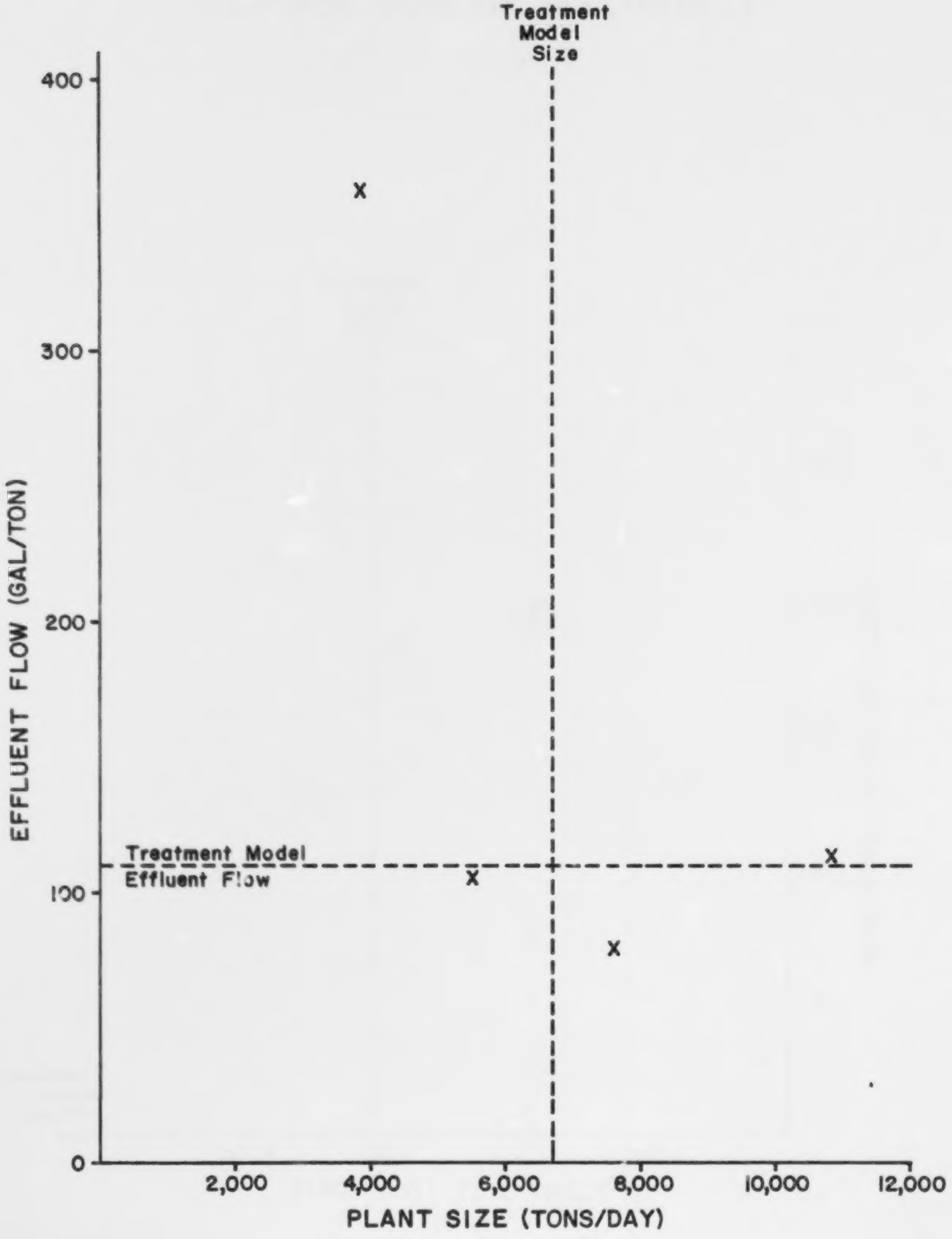


FIGURE IV-5

PLANT SIZE (PRODUCTION CAPACITY) vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE: SEMI-WET

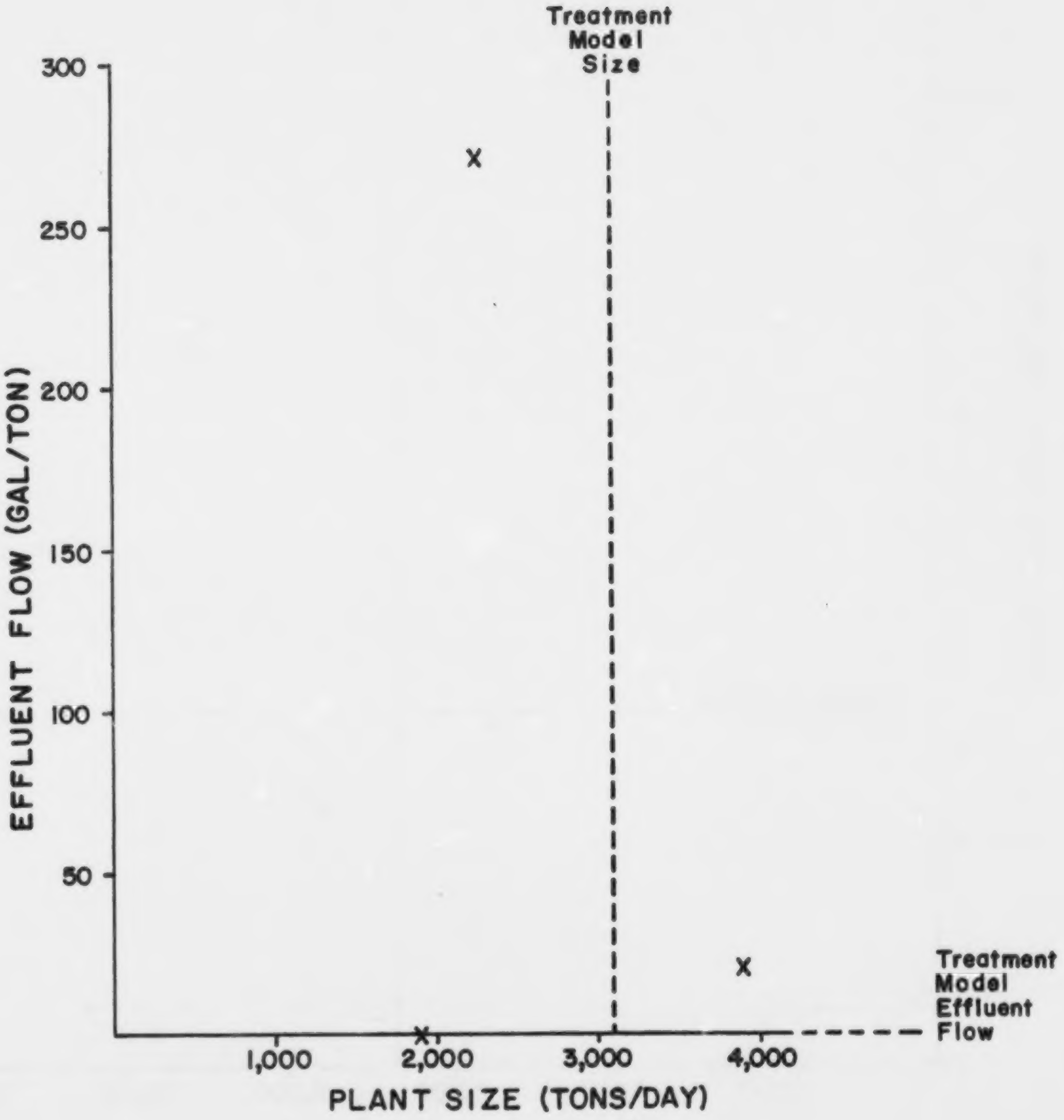


FIGURE IV-6

PLANT SIZE (PRODUCTION CAPACITY) vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE: WET

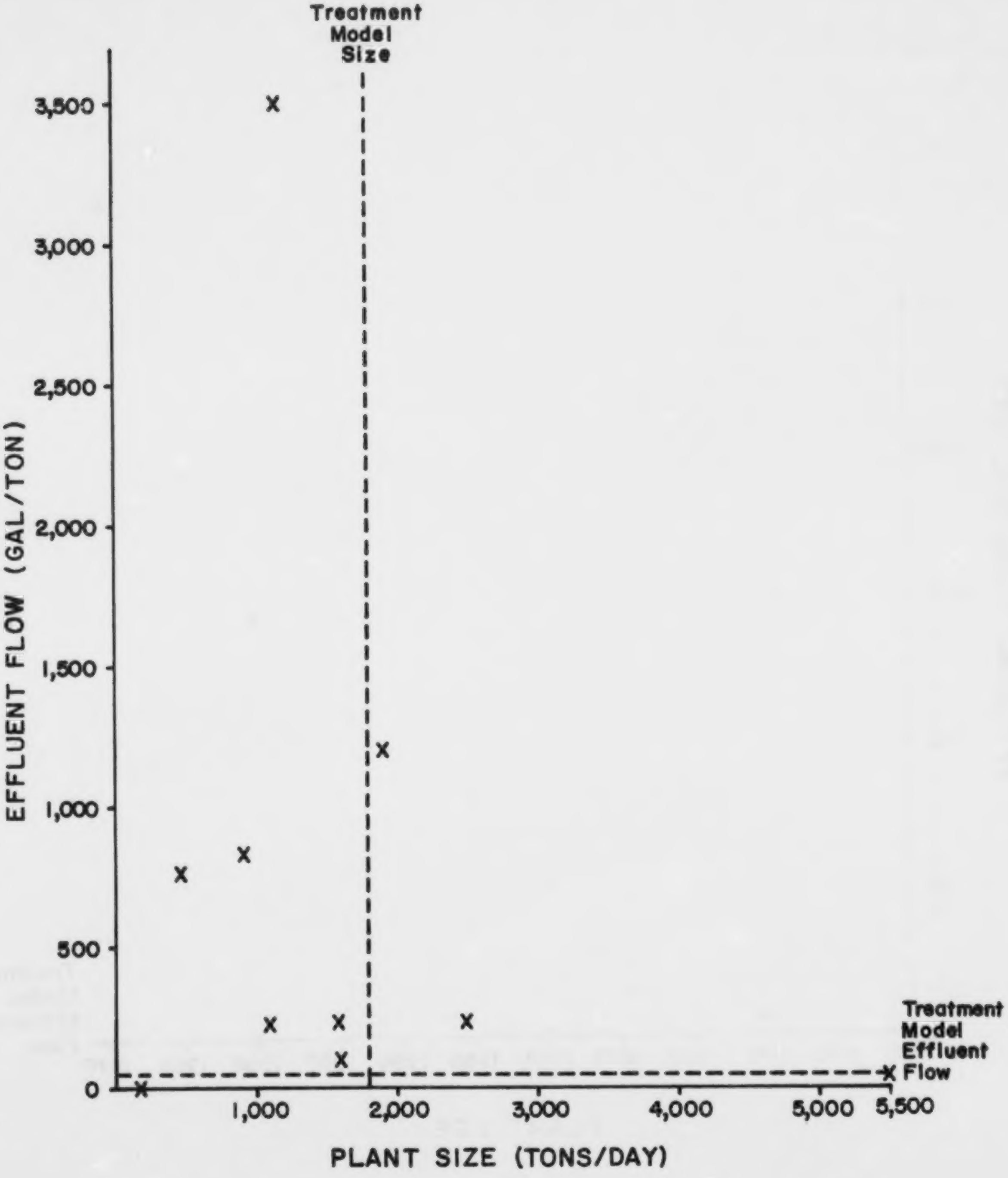


FIGURE IV - 7

PLANT AGE vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE: SEMI-WET

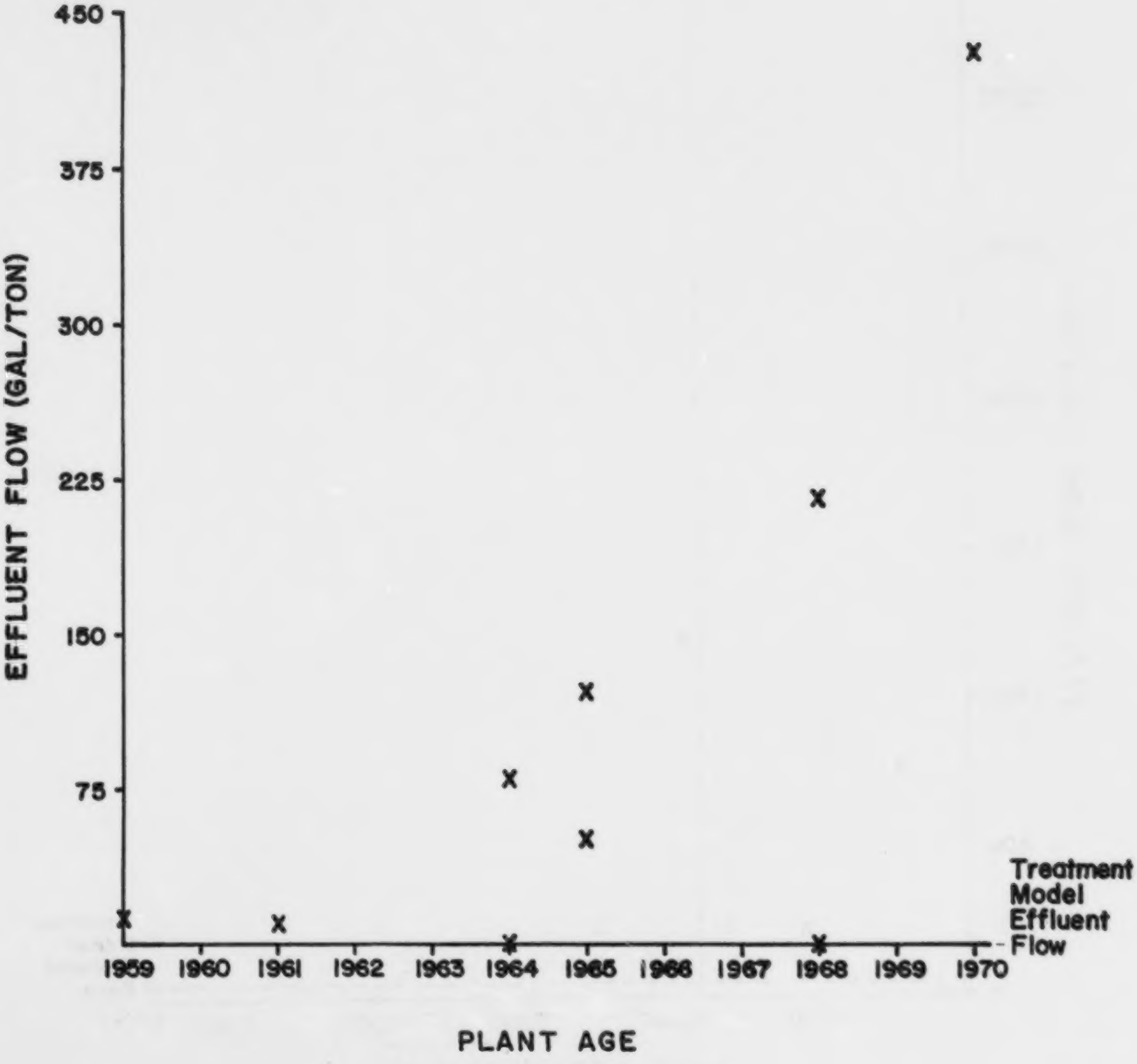


FIGURE IV-8

PLANT AGE vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE: WET-SUPPRESSED COMBUSTION

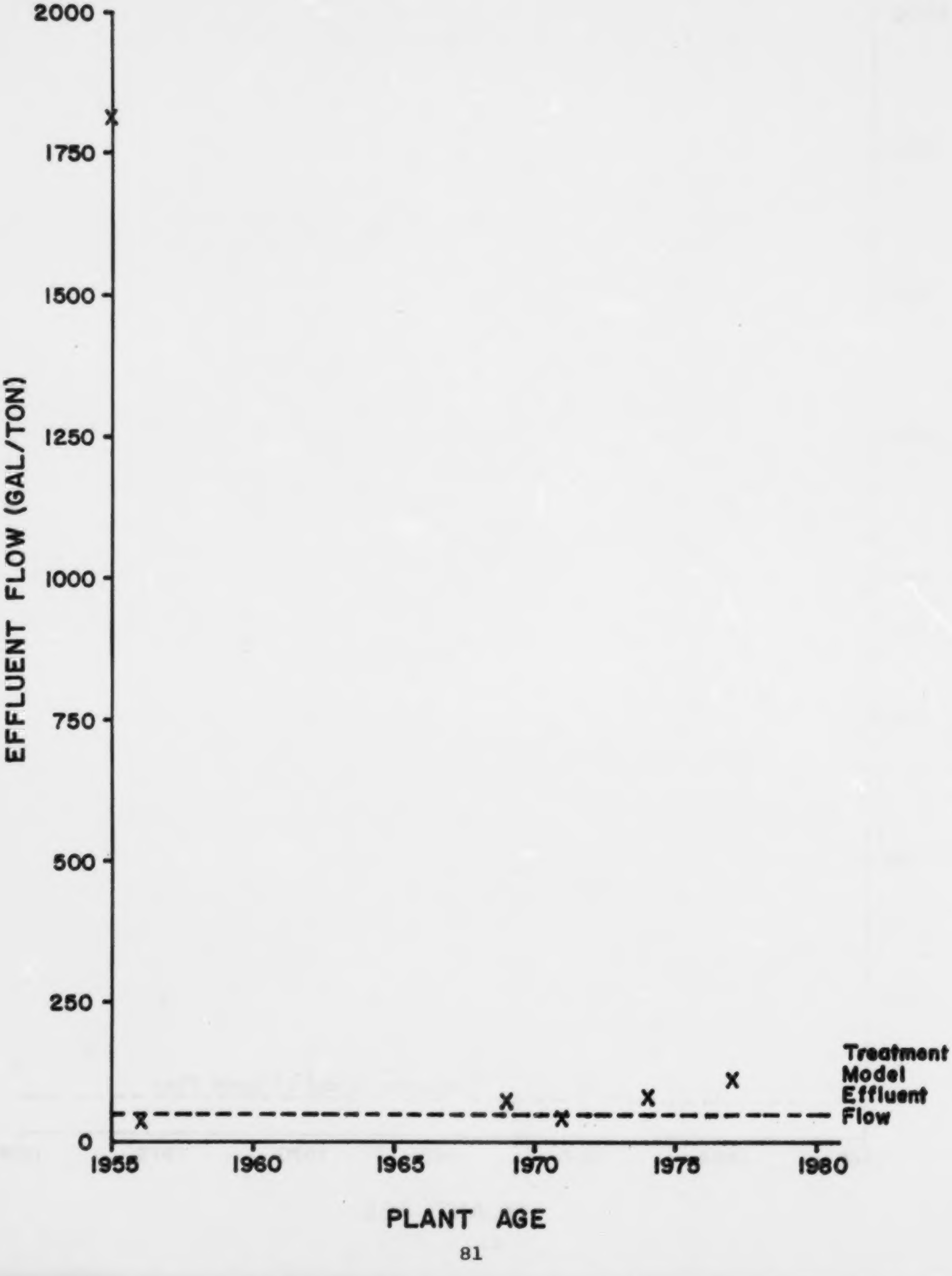


FIGURE IV-9

PLANT AGE vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE: WET-OPEN COMBUSTION

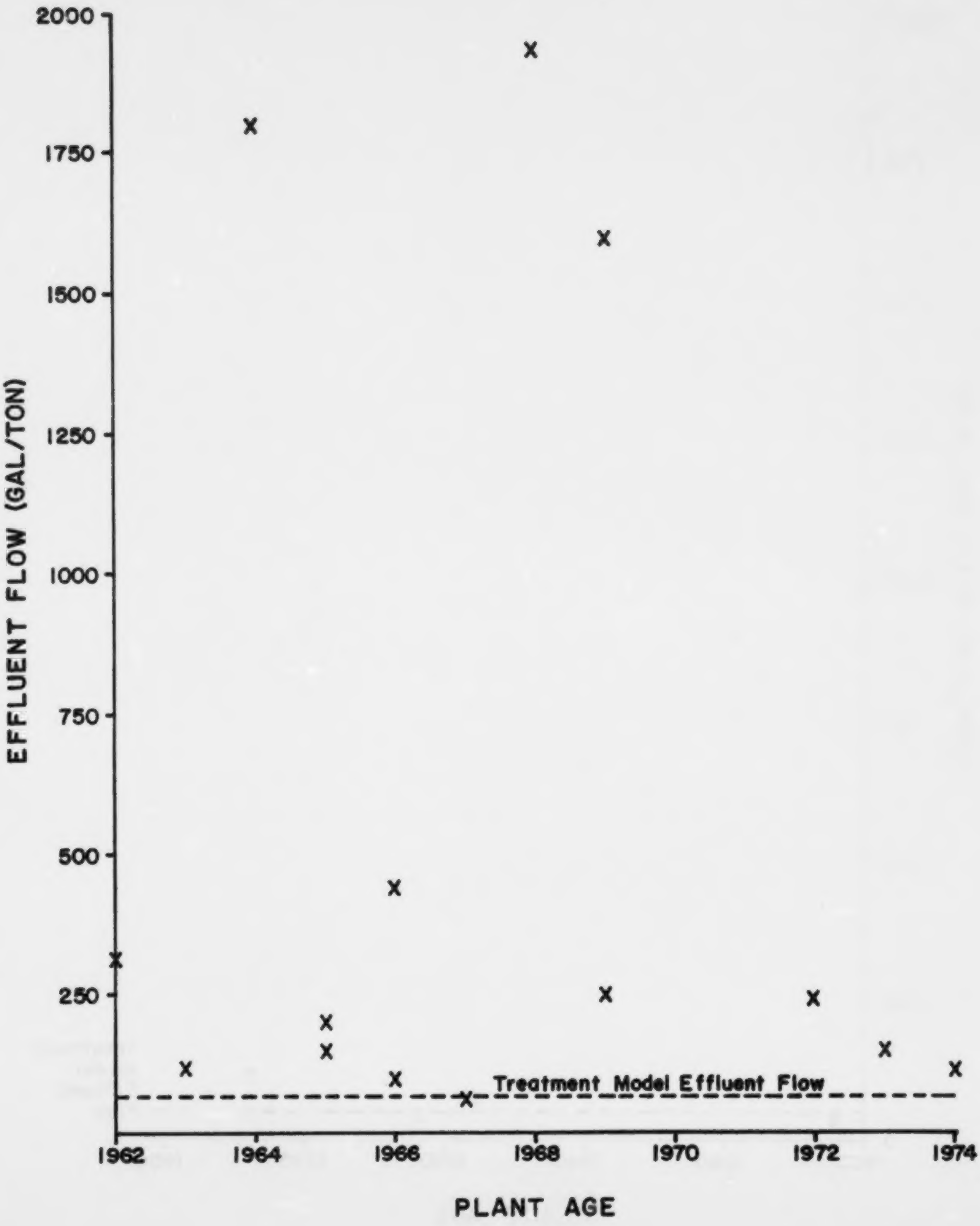


FIGURE IV-10

PLANT AGE vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACE: WET

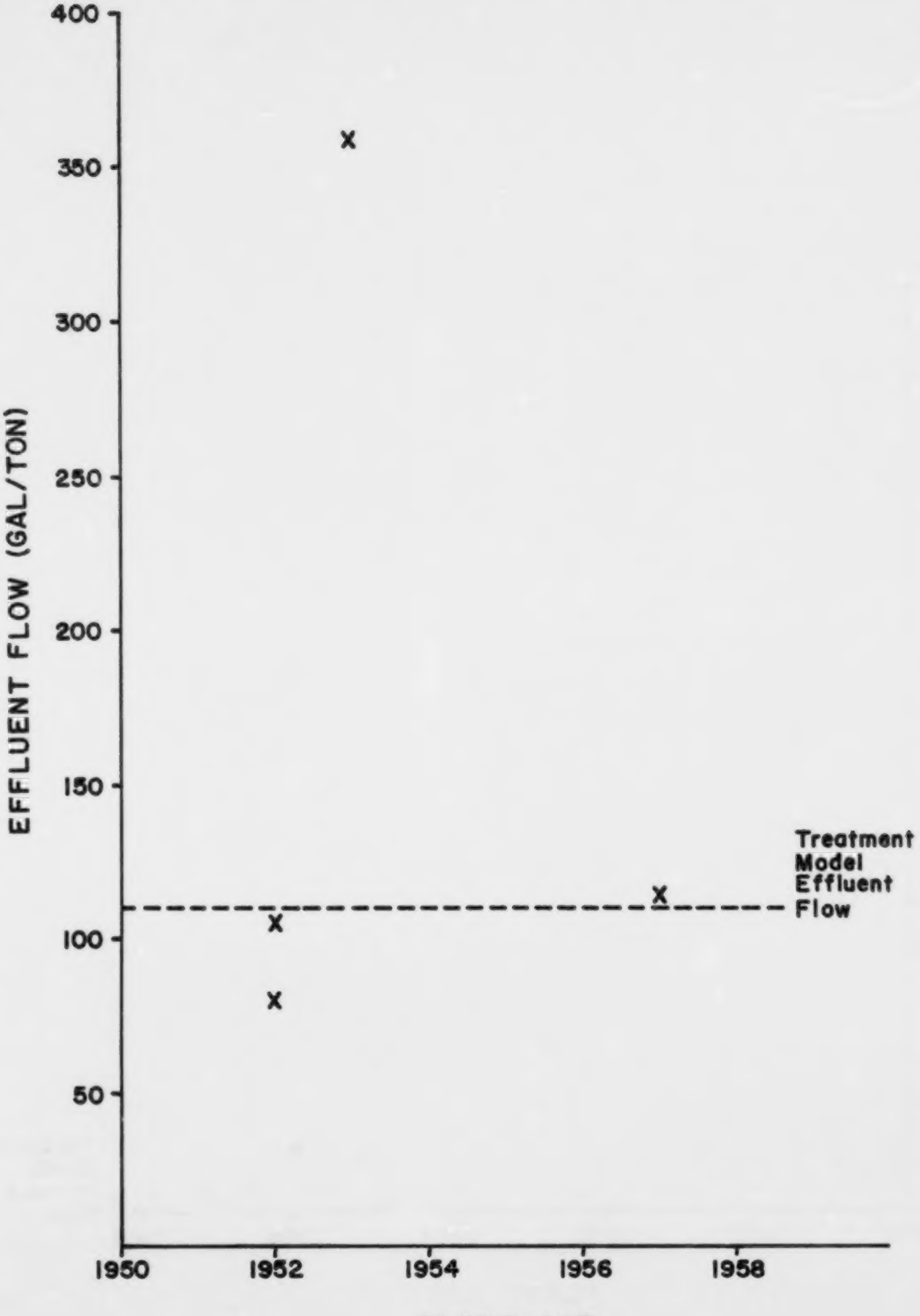


FIGURE IV-11

PLANT AGE vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE: SEMI-WET

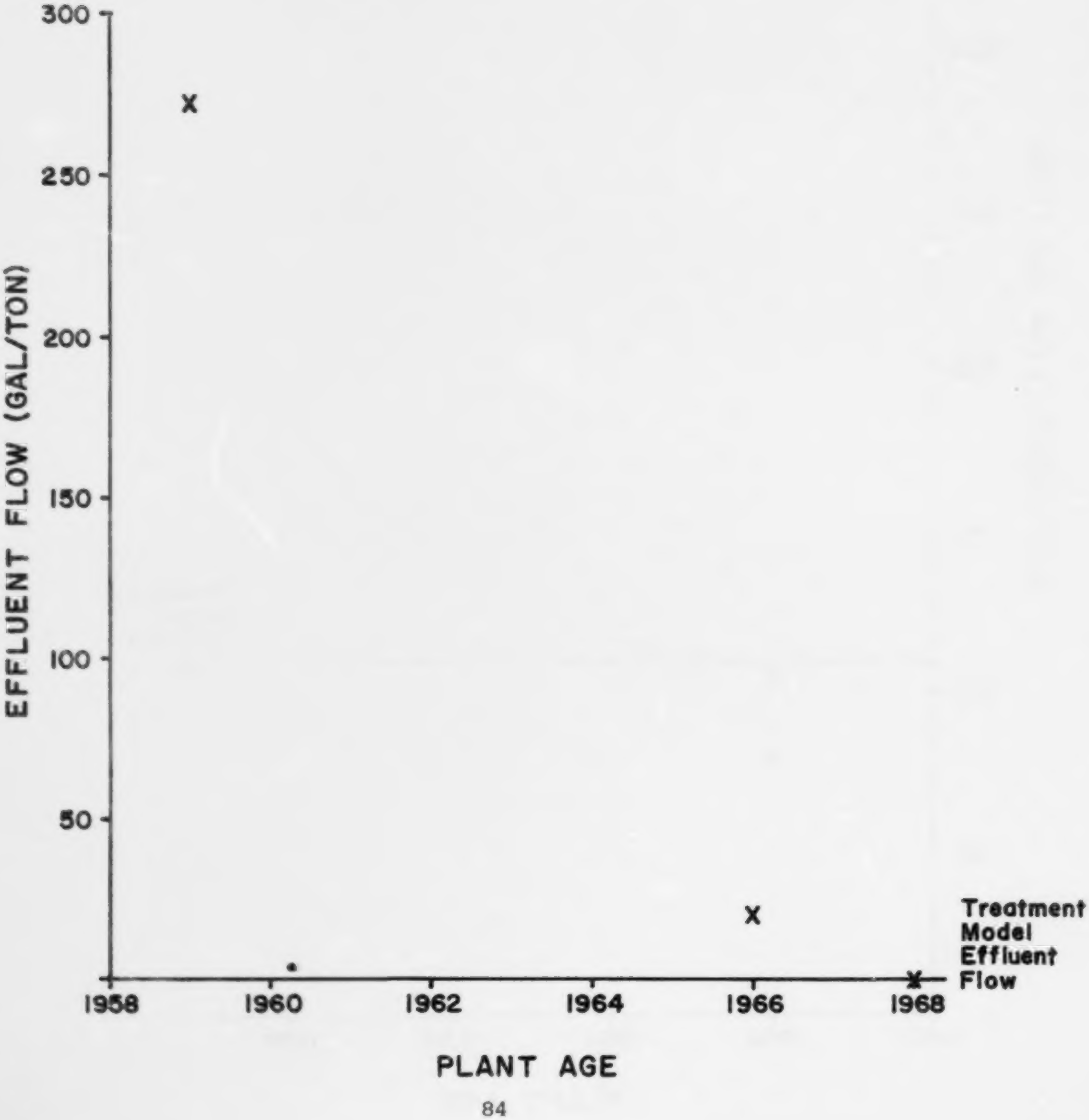
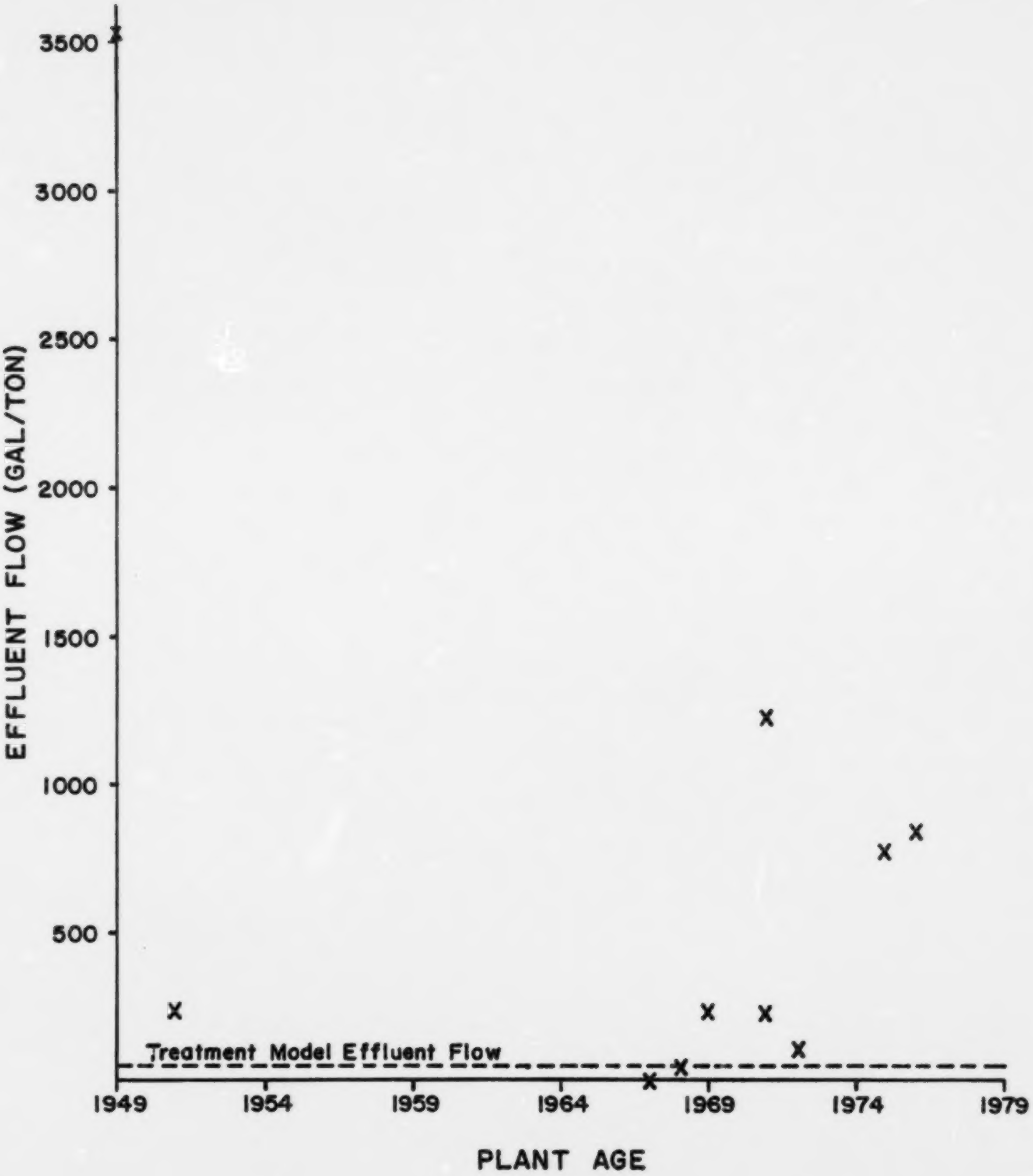


FIGURE IV-12

PLANT AGE vs EFFLUENT FLOW
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE: WET



STEELMAKING SUBCATEGORY

SECTION V

WATER USE AND WASTE CHARACTERIZATION

Introduction

This section describes the water systems in use in the steelmaking subdivisions and the types of wastewaters generated in each steelmakng process. The description of the wastewaters is limited to those waters which come into contact with, and are thus contaminated by, the pollutants generated in the steelmaking processes. The various noncontact cooling and nonprocess water systems are not considered in this review. Wastewater characterization for the steelmaking processes is based upon EPA survey data and data supplied by the industry.

Water Use

The steelmaking processes generate fumes, smoke, and waste gases as impurities are burned off and various elements in the molten steel are vaporized. The wastewaters are generated when semi-wet or wet gas collection systems are used to condition and clean the furnace off-gases. The particulate matter carried by the gas stream is the prinicpal source of pollutants which contaminate the process wastewaters.

The steelmaking process gas cleaning systems vary from dry to semi-wet, to wet. In the dry systems, baghouses or precipitators are used in conjunction with evaporation chambers to clean and condition the furnace off-gases, with the result that no process wastewaters or sludges are generated. The semi-wet systems, which operate with baghouses or precipitators and the "wet", high energy Venturi scrubber systems generate process wastewaters which require subsequent treatment. The selection of a gas cleaning system is dependent not only upon capital and operating costs, but also upon individual plant characteristics such as physical layout, resource availability, and available wastewater pollution control facilities (e.g., central treatment facilities).

Following are the four main water systems used in BOF steelmaking operations.

a. Oxygen lance cooling
b. Furnace trunnion ring and nose cone cooling
c. Hood cooling
d. Fume collection scrubber and gas cooling

Open hearth furnace operations use two main water systems:

a. Furnace cooling; checker reversal valve cooling
b. Fume collection scrubber and gas cooling

Electric arc furnace operations use two main water systems:

a. Electric arc furnace door, electrode ring, roof ring, cable and transformer cooling.
b. Fume collection scrubber and gas cooling

Only the gas cleaning and cooling systems are considered henceforth as the other systems use only noncontact cooling waters.

In the case of dry gas cleaning systems, waters are applied to the process off-gases to condition (i.e., to lower the temperature) of these gases prior to further cleaning in baghouses or electrostatic precipitators. Initial gas cooling in BOF operations is accomplished as the waste gases pass through a steam generating hood. This system, which involves only noncontact waters, provides a means of recovering waste heat. Waste gases are first cooled in open hearth operations as they pass through the refractory checkers. In the case of EAF operations, initial gas cooling is achieved in evaporation chambers. These chambers are large, refractory lined structures in which water is sprayed into the gas stream. An exact balance is maintained between the water supplied to the chamber and the water evaporated in cooling the hot gases, with the result that no process wastewaters are generated. The cooled gases can then be introduced to the baghouses or electrostatic precipitators. The precipitator systems in BOF operations require a minimum of 100 percent excess air to insure minimum noncombusted CO carry-over to the precipitators.

The semi-wet gas cleaning system also employs either a baghouse or precipitator to clean the furnace gases, however, the furnace off-gases are cooled in a spray chamber (for a baghouse system) or in a spark box (for a precipitator system). In order to insure proper temperature conditioning of the gases prior to cleaning, more water is sprayed into the system than can be evaporated. This practice results in the generation of a process wastewater which must then receive treatment prior to discharge. The resulting wastewaters range in temperature from 82°C to 88°C and contain solids comprised of iron oxides, fluxing materials, and lime. Plate panel hoods with 200 to 300 percent excess air are employed with these systems in BOF operations. The capital costs for spark box systems are less costly than the capital costs for steam generating systems with spray chambers.

With BOF operations, an alternate to the spark box spray or dry evaporation chamber systems is the wetted wall evaporation chamber system. A wetted wall evaporation chamber contains no refractory lining, but uses a wetted steel surface as the heat resistant medium. These chambers require large quantities of water to insure that the steel surfaces are not overheated. After it was sampled during the original guidelines survey, Plant "R" (0432A) converted this type of chamber to water cooled plate panel walls, thus eliminating wetted surfaces.

The wet fume collection systems for steelmaking operations make use of high energy Venturi scrubbers. In BOF and open hearth operations, the Venturi scrubber systems are generally coupled with low energy, fixed orifice quenchers which cool the gases to approximately 83°C. The gases are hotter exiting from the hood on a BOF operation wet scrubber system than on dry or semi-wet systems, because the maximum excess air admitted to the system is approximately 50% versus the 100 to 200% for precipitator systems. This decrease reduces horsepower requirements while still maintaining a minimum residual of CO in the gases. In some BOF operations, wet gas cleaning system horsepower requirements are further reduced by the use of large self-contained closed contact cooling towers, which reduce the gas temperatures from 83°C saturated to 43°C saturated. As the gases are saturated, cooling is accomplished solely by gas to water contact and heat transfer. The cooling towers are refractory lined, enclosed cylindrical steel towers with a packed bed of saddles, rings, etc. which provides intimate gas and water contact. As these cooling systems are installed on the clean gas side of the Venturi scrubbers, the cooling waters are recycled after passing through induced draft cooling towers. Chemicals are added to the recycled waters to prevent fouling of the system and the cooling tower. Makeup water is added to compensate for evaporative losses, blowdown, and cooling tower drift. The cooling tower system could be "once-through" if large quantities of clean water are available. In addition, waters in the gas stream will be condensed as the gases are further cooled in these packed towers.

An alternative to the Venturi scrubber system is the wet gas washer and disintegrator system. This system has limited use, however, as the larger gas volumes handled in this system result in greater horsepower requirements to operate the disintegrator.

In conjunction with the water systems described above, the recycle of process wastewaters has become a common mode of operation in both the semi-wet and wet gas cleaning systems. In semi-wet operations, process wastewaters are recycled to the spark box, while in the wet systems, treated wastewater is recirculated to the scrubber, the effluent of which is then delivered to the quencher. Most steelmaking operations use recycle to some degree, as shown in Tables V-1 through V-3. These tables show that several plants recycle more than ninety percent of their process effluents. The use of recycle is considered to be good water conservation practice as it not only reduces the volume of fresh water needed by the gas cleaning system, but it also reduces the volume of wastewater discharged.

Waste Characterization

The raw wastewaters from the semi-wet and wet gas cleaning systems of each steelmaking subdivision are similar in waste characterization in that toxic metals, fluoride, and significant quantities of suspended solids are present in wastewaters from the three systems. Raw wastewater pH values are also similar. The levels of the various pollutants, however, vary among the systems. The toxic metals are found in the process wastewaters as a result of the volatilization of the metals from the molten steel. The presence of zinc, one of the prominent toxic metal pollutants in steelmaking process wastewaters, can be directly related to the use of galvanized scrap in the furnace charge. Fluoride concentrations vary in relation to the amount of fluorspar (a fluxing compound) used in the process. The use of different fuels for firing open hearth furnaces results in the generation of nitrous and sulfur oxides, which subsequently depress the pH of open hearth furnace wastewaters. The generation of particulate matter has been previously discussed in Sections III and IV.

Tables V-4 through V-13 summarize the concentration data for wastewater pollutants picked up in each pass through the respective steelmaking processes. These values provide a measure of the pollutants contributed by the process. These concentration values were calculated by subtracting out all "background" pollutant concentrations.

As noted in Table V-12, raw wastewater samples could not be obtained for Plant Z, as this plant (Plant 0584A) employes a closed system and is inaccessible to sampling. Data for the one semi-wet EAF operation sampled during the toxic pollutant survey (Plant 059B) are not presented as there are insufficient data to properly evaluate the net calculation. Data for EAF Plants AA and AB, sampled for the original guidelines survey, are not presented. Plant AA was resampled as Plant 059A and hence appears in Table V-13. The toxic pollutant survey data were given precedence as they are more complete and representative of current operations. Plant AB was not included because the plant configuration precluded the collection of representative raw wastewater samples. The pollutants presented in these tables (other than the previously limited pollutants) were selected on the basis of their presence in the raw wastewaters at net concentrations of 0.01 mg/l or more.

After reviewing the net and gross concentration values of those pollutants considered for limitation in the steelmaking subcategories, the Agency determined that the effect of makeup water on these streams is not significant. Consequently, the proposed effluent limitations and standards are based on gross values.

TABLE V-1

RECYCLE RATES
BASIC OXYGEN FURNACES

	Plant Reference Code	% Recycle
Semi-Wet		
	0196A	0
	0396D	90.5
	0432A	100
	0432C	0
	0584C	0
	0684B	0
	0684G	0
	0684I	0
	0920B	NA
	0946A	93.7
Wet-Suppressed Combustion		
	0060	96.0
	0384A	94.0
	0528A	0
	0684F	94.2
	0684H	90.0
	0856N	96.9
Wet-Open Combustion		
	0020B	71.9
	0112A	66.8
	0112B	0
	0112D	46.3
	0248A	0
	0384A	89.1
	0584F	75.2
	0724A	80.0
	0856B	0
	0856R	90.9
	0860B	84.4
	0860B	88.4
	0860H	18.0
	0868A	89.2
	0920N	34.4

TABLE V-2

RECYCLE RATES
OPEN HEARTH FURNACES

	Plant Reference Code	% Recycle
Semi-wet	0864A	93.8
Wet	0060	97.6
	0112A	87.5
	0492A	29.1

TABLE V-3

RECYCLE RATES
ELECTRIC ARC FURNACE

	Plant Reference Code	% Recycle
Semi-wet	0060F	0
	0432C	0(1)
	0584A	(2)
Wet	0060D	72.0
	0060F	89.7
	0492A	29.0
	0528A	0
	0612	98.1
	0856F	95.0
	0860H	67.0(3)
	0860H	48.0(3)
	0868B	91.1
	0940	(2)

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(1) Process water is completely reused.

(2) All waters are evaporated. Only wet sludges are removed from the process.

(3) Remaining percentage is reused.

TABLE V-4

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - SEMI-WET

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code	0432A	0396D	Average(1)
Plant Code	R	U	
Sample Points	#1-#2	#1-#4	
Flow, gal/ton	130	728	429
	mg/l	mg/l	mg/l
Suspended Solids	197	396	297
Fluoride	NR	2.4	2.4
pH (Units)	11.4	11.8	11.4-11.8
119 Chromium	-	NR	+
120 Copper	0.03	0.05	0.04
122 Lead	1.26	+	1.26
123 Mercury	0.0029	-	0.0029
128 Zinc	0.68	1.05	0.86

---

(1) Negative values were not used in calculating the average.

NR: Value not reported.
- : Calculation yields a negative result.
+ : Cannot be evaluated.

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE V-5

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

Pick-up per pass concentrations of pollutants in raw wastewaters.

	Reference Code	0060
	Plant Code	S
	Sample Points	#1-#2
	Flow, gal/ton	982
		mg/l
	Suspended Solids	337
	Fluoride	NR
	pH (Units)	8.8
120	Copper	+
122	Lead	3.40
123	Mercury	0.0004
128	Zinc	16

NR: Not Reported
+ : cannot be evaluated

NOTE: All values expressed in mg/l unless otherwise noted.

TABLE V-6

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code		0384A	0856N	0684F	Averages
Plant Code		032	034	038	
Sample Points		B+C+D-G	B-C-A	B-C-E	
Flows, (gal/ton)		1470	1150	569	1060
		mg/1	mg/1	mg/1	mg/1
	Suspended Solids	1450	333	645	809
	Fluoride	NR	NR	NR	NR
	pH (Units)	8.7	9.4	11.3	8.7-11.3
4	Benzene	-	0.000	-	0.000
22	Parachlorometa cresol	0.003	-	-	0.001
23	Chloroform	-	-	-	0.000
39	Fluoranthene	0.007	0.000	0.001	0.003
65	Phenol	0.000	-	0.008	0.003
84	Pyrene	0.005	0.000	-	0.002
86	Toluene	0.001	-	0.003	0.001
89-105	Pesticides	0.000	0.000	0.000	0.000
106-112	PCB's	0.000	0.000	0.000	0.000
113	Toxaphene	0.000	0.000	0.000	0.000
114	Antimony	NR	0.004	NR	0.004
115	Beryllium	-	NR	-	0.000
118	Cadmium	0.091	NR	0.032	0.062
119	Chromium	1.05	NR	0.156	0.602
120	Copper	0.311	0.009	0.063	0.128
121	Cyanide	0.001	-	-	0.0003
122	Lead	26.5	0.699	NR	13.6
123	Mercury	-	0.0002	0.0000	0.00007
124	Nickel	0.327	-	0.021	0.116
125	Selenium	NR	0.003	NR	0.003
126	Silver	0.019	NR	0.005	0.012
128	Zinc	8.33	NR	NR	8.33

- : Calculation Yielded Negative Result
NR: Not Reported

NOTE: All values are expressed in mg/1 unless otherwise noted.

TABLE V-7

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code	0112A	0584F	Average
Plant Code	T	V	
Sample Points	#1-#2-#4	#5-#6-#7	
Flow, (gal,ton)	633	259	446
	mg/l	mg/l	mg/l
Suspended Solids	3739	5338	4539
Fluoride	10.8	+	10.8
pH (Units)	8.0	3.4	3.4-8.0
120 Copper	2.1	+	2.1
122 Lead	+	+	+
123 Mercury	0.0019	0.0004	0.0012
128 Zinc	5.4	193	99.2

+ : Cannot be evaluated.

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE V-8

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

Pick-up per pass concentrations of pollutants in raw process wastewaters.

Reference Code		0020B	0856B	0868A	0112D	Averages
Plant Code		031	033	035	036	
Sample Points		B-A	C-A	L-A-M	O-Q	
Flow, (gal/ton)		1058	241	1046	454	717
		mg/l	mg/l	mg/l	mg/l	mg/l
Suspended Solids		367	7669	877	7087	4000
Fluoride		NR	NR	NR	8.6	8.6
pH (Units)		8.1	11.7	8.4	11.3	8.1-11.7
4	Benzene	0.000	0.000	0.003	-	0.001
10	1,2-Trans dichloroethane	0.000	0.000	0.000	0.010	0.002
23	Chloroform	0.032	-	0.042	-	0.018
39	Fluoranthene	0.000	0.034	-	0.000	0.008
73	Benzo(a)pyrene	0.000	0.007	0.007	0.000	0.004
76	Chrysene	-	0.026	0.003	0.000	0.007
84	Pyrene	0.000	0.032	-	0.000	0.008
114	Antimony	0.017	-	NR	NR	0.008
115	Arsenic	0.048	0.072	NR	NR	0.060
117	Beryllium	NR	0.000	-	0.0067	0.002
118	Cadmium	0.261	NR	0.019	0.174	0.152
119	Chromium	17.1	-	0.018	0.367	4.37
120	Copper	1.20	0.877	0.015	0.334	0.606
121	Cyanide	-	-	0.002	0.004	0.002
122	Lead	0.775	12.8	0.022	0.367	3.49
123	Mercury	0.033	0.0001	0.0002	0.0335	0.0167
124	Nickel	NR	+	-	0.047	0.024
125	Selenium	0.003	0.032	NR	NR	0.108
126	Silver	NR	+	0.000	0.043	0.026
127	Thallium	0.015	-	NR	NR	0.008
128	Zinc	3.26	48.7	3.33	2.004	14.3

NR: Not reported.
- : Calculation yielded negative result.
+ : Cannot be evaluated.

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE V-9

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACE - SEMI-WET

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code		0864A
Plant Code		043
Sample Points		B-C
Flow, gal/ton		1163
		mg/l
Suspended Solids		480
Fluoride		222
pH (Units)		2.4
4	Benzene	-
23	Chloroform	0.014
86	Toluene	0.003
118	Cadmium	-
119	Chromium	0.075
120	Copper	0.070
121	Cyanides	0.036
122	Lead	+
124	Nickel	0.047
128	Zinc	0.43

+: Cannot be evaluated
-: Calculation yields a negative result

NOTE: All values expressed in mg/l unless otherwise noted.

TABLE V-10

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACE - WET

Pick-up per pass concentrations of pollutants in raw wastewater.

Reference Code	0112A	0060	Average(1)
Plant Code	W	X	
Sample Points	#1-#2-#4	#1-#2-#4	
Flow, gal/ton	607	500	578
	mg/l	mg/l	mg/l
Suspended Solids	-	3894	3894
Fluoride	22.4	16	19.2
pH (Units)	3.7	6.2	3.7-6.2
120 Copper	-	3.4	3.4
122 Lead	0.19	NR	0.19
123 Mercury	0.0007	-	0.0007
128 Zinc	-	*	+

---

(1) Negative values were not used in calculating the averages.

NR: No value was reported.
-: Calculation yields a negative result.
*: A representative sample was not obtained.
+: Cannot be evaluated.

NOTE: All values expressed in mg/l unless otherwise noted.

TABLE V-11

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACE - WET

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code	0492A
Plant Code	042
Sample Points	C-A-D
Flow, gal/ton	506
	mg/l
Suspended Solids	15.10
Fluoride	92
pH (Units)	6.7
23 Chloroform	-
128 Zinc	389

-: Calculation yields a negative result

TABLE V-12

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE - SEMI-WET

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code	0432C	0584A	Average
Plant Code	Y	Z	
Sample Points	#1 - #2	NA	
Flow, Gal/Ton	97	NA	97
Suspended Solids	1070	*	1070
Fluoride	-	*	+
pH (Units)	7.83	*	7.83
120 Copper	0.408	*	0.408
122 Lead	15.3	*	15.3
128 Zinc	14.5	*	14.5

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* : No samples of the raw or treated wastewaters could be obtained during the survey. This plant utilizes a closed system and is inaccessible to sampling. The only sample obtained was of the sludge leaving the system.

- : Calculation yields a negative result.

+ : Calculation cannot be evaluated.

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE V-13

SUMMARY OF ANALTYICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACE - WET

Pick-up per pass concentrations of pollutants in raw wastewaters.

Reference Code	0612	0492A	0060F	Average
Plant Code	051	052	059A	
Sample Points	B-E-D	B-A-D	F-G-I	
Flow, Gal/Ton	720	1178	2300	1399
Suspended Solids	2761	886	6298	3308
Fluoride	NR	NR	44	44
pH (Units)	7.1	9.0	7.1	7.1 - 9.0
4 Benzene	-	-	0.022	0.007
24 2-Chlorophenol	-	0	0.016	0.005
39 Fluoranthene	-	0	0.056	0.019
58 4-Nitrophenol	0.007	0	0.031	0.013
64 Pentachlorophenol	0.003	0	0.038	0.014
84 Pyrene	-	0	0.050	0.017
114 Antimony	0.661	NR	NR	0.661
115 Arsenic	1.22	NR	NR	1.22
118 Cadmium	1.81	NR	NR	1.81
119 Chromium	3.76	NR	NR	3.76
120 Copper	1.25	NR	NR	1.25
122 Lead	21.5	NR	NR	21.5
123 Mercury	0.0009	+	NR	0.0009
124 Nickel	0.033	NR	NR	0.033
126 Silver	0.053	NR	NR	0.053
128 Zinc	80.0	+	+	80.0

NR: No value was reported
+ : Calculation cannot be evaluated
- : Calculation yielded a negative result

NOTE: All values are expressed in mg/l unless otherwise noted.

STEELMAKING SUBCATEGORY

SECTION VI

WASTEWATER POLLUTANTS

Introduction

This section describes the selection, rationale for selection, and process sources of those pollutants characteristic of wastewaters from the various steelmaking processes. The initial task was to develop a list, based upon data obtained from the DCP responses and during the original guidelines survey, of pollutants considered to be representative of each steelmaking process. This initial list was then confirmed by and augmented with analytical data obtained during the toxic pollutant survey. The final selection of pollutants for each steelmaking operation was based upon a review of all analytical data and consideration of each pollutant's impact and its ability to serve as an indicator of wastewater contamination and treatment performance.

Conventional Pollutants

The originally promulgated BPT limitations for the steelmaking subdivisions contained limitations for suspended solids and pH. The Agency established limitations for suspended solids based upon the substantial quantities of fume particulates generated in the steelmaking processes and carried away by process off-gases. As water is used to condition and clean these gases, the fume particulates are transferred to the process waters. Suspended solids levels provide an indication of the degree to which the process wastewaters are contaminated and of wastewater treatment performance. The removal of suspended solids will also result in the removal of certain toxic metals which are entrained in the suspended solids.

The Agency selected pH (a measure of a wastewater's acidity or alkalinity) for limitation because of the detrimental environmental impacts which can result from extremes in the pH of a wastewater discharge. In addition, pH extremes can cause other problems, such as corrosion or failure of the process and wastewater treatment equipment and facilities. Basic oxygen furnace raw wastewater pH values are typically in the alkaline range due to the composition of the furnace gases. Open hearth raw wastewaters are typically acidic, again, because of the nature of the gases. The acidity of the raw wastewaters is primarily caused by the scrubbing of sulfur oxides, which are found in the gases as a result of the various fuels which are used to fire the furnace. The pH of electric arc furnace raw wastewater is typically in the neutral range of pH values (6.0 to 9.0).

Nonconventional, Nontoxic Pollutants

The presence of fluoride in steelmaking process wastewaters is related to the use of fluorspar in the steelmaking process. Although not included in the list of toxic pollutants, fluoride has exhibited effects which are detrimental to the environment. Fluoride is typically present in only moderate amounts in BOF raw wastewaters. However, substantial amounts of fluoride can be found in open hearth and EAF raw wastewaters since the use of fluorspar is related to the amount of scrap used in the furnace charge.

Toxic Pollutants

This study also considered the discharge of toxic pollutants. Initially, the Agency developed a list of pollutants "known to be present" in steelmaking wastewaters based upon industry responses to the DCPs, analyses performed during the screening phase of the project, and knowledge of the character of steelmaking process wastewaters. Tables VI-1 through VI-3 present lists of these pollutants for each steelmaking subcategory.

Upon completion of the analytical tasks for steelmaking operations, the Agency tabulated the data and calculated a net concentration value for each pollutant detected in raw wastewaters at 0.010 mg/l or greater. "Pick-up per pass" raw concentrations were used for the reasons noted in Section V. Those pollutants which were found at average net concentrations of less than 0.010 mg/l were excluded from further consideration. The Agency then developed lists of selected pollutants, including the conventional and nonconventional pollutants, for the steelmaking subdivisions. The final lists of selected pollutants are presented in Tables VI-4 through VI-6.

The toxic metal pollutants originate in the raw materials (primarily the scrap) charged to the steelmaking furnaces. Subsequently, these metals contaminate process wastewaters by the fume particulates which are scrubbed from furnace off-gases. In all subcategories, zinc is the predominant toxic metal found in the process wastewaters. Raw wastewater zinc levels will increase significantly as galvanized steel scrap comprises a larger portion of the furnace charge.

Although the Agency found a number of toxic organic pollutants in steelmaking wastewaters, Tables VI-4 through VI-6 do not include all of these pollutants. The Agency did not include many of those pollutants (e.g., phthalates) because it believes that their detection during the toxic pollutant survey results not from their presence in the wastewaters but from the sampling and laboratory procedures. The remaining organic pollutants (primarily in EAF operations) may originate with the scrap charge to the furnaces and were included in the pollutant list. In addition to the organic pollutants found on the scrap steel as a result of machining and handling, the solvents used in a number of instances to clean the scrap steel are also a source of organic pollutants. However, the Agency is not proposing limitations for these pollutants. The Agency believes that pollutants do not tend to concentrate in recycle systems. Although the concentration in recycle system blowdowns will be approximately the same as in once-through systems, the mass loadings of those pollutants to the environment will be reduced proportionately to the degree of recycle. Accordingly, the Agency believes that compliance with the proposed BAT limitations indicates a comparable reduction in the discharge of the toxic organic pollutants present in steelmaking wastewaters.

Other pollutants (i.e., chloride, sulfate) are present at substantial levels in the process wastewaters, but are not included in the list of selected pollutants since they are nontoxic in nature and difficult to remove. Treatment of these pollutants is not commonly practiced in the wastewater treatment operations of any industry.

TABLE VI-1

TOXIC POLLUTANTS KNOWN TO BE PRESENT BASIC OXYGEN FURNACE

4. Benzene
23. Chloroform
65. Phenol
85. Tetrachloroethylene
86. Toluene
115. Arsenic
118. Cadmium
119. Chromium
120. Copper
121. Cyanide
122. Lead
123. Mercury
124. Nickel
125. Selenium
126. Silver
127. Thallium
128. Zinc

TABLE VI-2

TOXIC POLLUTANTS KNOWN TO BE PRESENT OPEN HEARTH FURNACE

65. Phenol
114. Antimony
115. Arsenic
118. Cadmium
119. Chromium
120. Copper
121. Cyanide
122. Lead
123. Mercury
124. Nickel
128. Zinc

TABLE VI-3

TOXIC POLLUTANTS KNOWN TO BE PRESENT ELECTRIC ARC FURNACE

4. Benzene
39. Fluoranthene
48. 4-Nitrophenol
64. Pentachlorophenol
84. Pyrene
114. Antimony
115. Arsenic
118. Cadmium
119. Chromium
120. Copper
122. Lead
124. Nickel
126. Silver
128. Zinc

TABLE VI-4

SELECTED POLLUTANTS
BASIC OXYGEN FURNACE SUBDIVISON

Semi-Wet	Wet-Suppressed Combustion	Wet-Open Combustion
Suspended Solids	Suspended Solids	Suspended Solids
Fluoride	Fluoride	Fluoride
pH	pH	pH
120 Copper	118 Cadmium	23 Chloroform
122 Lead	119 Chromium	115 Arsenic
123 Mercury	120 Copper	118 Cadmium
128 Zinc	122 Lead	119 Chromium
	124 Nickel	120 Copper
	126 Silver	122 Lead
	128 Zinc	123 Mercury
		124 Nickel
		125 Selenium
		126 Silver
		127 Thallium
		128 Zinc

TABLE VI-5

SELECTED POLLUTANTS
OPEN HEARTH FURNACE SUBDIVISION

Semi-Wet		Wet	
	Suspended Solids		Suspended Solids
	Fluoride		Fluoride
	pH		pH
119	Chromium	120	Copper
120	Copper	122	Lead
121	Cyanide	128	Zinc
124	Nickel		
128	Zinc		

TABLE VI-6

SELECTED POLLUTANTS
ELECTRIC ARC FURNACE SUBDIVISION

Semi-Wet	Wet
Suspended Solids	Suspended Solids
Fluoride	Fluoride
pH	pH
120 Copper	4 Benzene
122 Lead	39 Fluoranthene
128 Zinc	58 4-Nitrophenol
	64 Pentachlorophenol
	84 Pyrene
	114 Antimony
	115 Arsenic
	118 Cadmium
	119 Chromium
	120 Copper
	122 Lead
	124 Nickel
	126 Silver
	128 Zinc

STEELMAKING SUBCATEGORY

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

Introduction

A review of the control and treatment technologies currently in use or available for use in the steelmaking subcategories provided the basis for the selection and development of the BPT model and BAT, NSPS, PSES, and PSNS alternative treatment systems. This review involved summarizing the questionnaire and plant visit data to identify those wastewater treatment components and systems in use at the various steelmaking operations. Capabilities, either demonstrated in this or in other operations (refer to Volume I) were used in evaluating the various treatment technologies to determine which treatment components are appropriate for the various levels of treatment. This section presents a summary of the treatment practices currently in use or available for use in the treatment of steelmaking process wastewaters.

This section also presents raw wastewater and treated effluent analytical data for the plants sampled, as well as long-term effluent analytical data provided in the D-DCPs. Also included are treatment facility descriptions of each sampled plant.

Summary of Treatment Practices Currently Employed

A survey of the treatment components used within the steelmaking subcategory indicates that all of the plants use gravity sedimentation, usually as an initial treatment step. Most plants also practice recycle, typically following sedimentation. In addition, several steelmaking operations discharge process wastewaters to central (i.e., multi-waste source or multi-operational waste source) treatment facilities for further treatment.

Referring to Tables III-5 through III-10, the following treatment technologies have been noted as in use at many steelmaking operations.

A. Neutralization with Lime

In the case of the open hearth furnace operations, lime is added to the process wastewaters for the purpose of adjusting the pH of the typically acidic process wastewaters to the neutral range (6.0 to 9.0).

B. Thickener

Sedimentation components are used in all steelmaking subcategories to remove the substantial amounts of particulate matter generated in the process and transported by the process wastewaters.

C. Coagulant Aid Addition

Coagulant aids (i.e., polymeric flocculants) are added to the process wastewaters in all of the steelmaking subdivisions to enhance suspended solids removal.

D. Vacuum Filter

Vacuum filters are used in all of the subdivisions to dewater the sludges removed from the sedimentation components. By dewatering the substantial quantities of solids which are removed from the process wastewaters, the costs of sludge handling and disposal are reduced.

E. Recycle

In the semi-wet air pollution control system segments, the entire effluent of the sedimentation component is recycled to the process. However, in the wet air pollution control system segments, most of the clarified effluent is recycled. The remainder of the effluent is discharged in the wet segments. Makeup water is added to replace water lost through evaporation in the gas cleaning system or as moisture in the dewatered solids.

F. Neutralization with Acid

In the case of the BOF wet air pollution control system segments, acid is added to the recycle system blowdown to adjust the pH of the typically alkaline wastewaters to the neutral pH range (6.0 to 9.0).

The above components have been included in the BPT model treatment systems on the basis of their widespread use at the various steelmaking processes.

Control and Treatment
Technologies for BAT, NSPS, PSES, and PSNS

The presence of nonconventional and inorganic toxic pollutants in process wastewaters from steelmaking operations with wet air pollution control systems led the Agency to consider advanced levels of treatment for use in the BAT, NSPS, PSES, and PSNS treatment systems. The Agency did not give such a consideration to the semi-wet gas cleaning systems because the BPT model treatment systems provides for the recycle of all process wastewaters. Following is a brief discussion of each of the treatment steps considered by the Agency.

Filtration is a common and effective means of removing suspended solids and, in particular, those pollutants (especially the toxic metals) entrained in these solids. A BOF discharging to a central treatment facility has this technology in place. Filtration is well demonstrated in many other wastewaters treatment applications in other subcategories. Generally, the filter bed is comprised of one or more filter media (i.e., sand, anthracite, garnet), while a variety of filtration systems are available (flat bed, deep bed, pressure, or gravity). The primary reason for applying this technology to the treatment of steelmaking process wastewaters is the removal of toxic metals.

Lime precipitation is effective for removing various pollutants. Significant reductions in fluoride levels and loads are achieved with lime precipitation as a result of the formation of calcium fluoride precipitates. Lime addition also achieves additional toxic metals removals through the formation of metal hydroxide precipitates. Lime addition, for the purpose of precipitating fluorides from process wastewaters, has been demonstrated in the steelmaking subdivisions, in this industry, and in other industries. In order to remove the solids and precipitates added and formed as a result of lime addition to steelmaking wastewaters, an inclined plate separator is included in the treatment system in conjunction with lime addition. Inclined plate separators are gravity sedimentation devices with effective settling areas much larger than the actual equipment size. The number of mechanical components is also reduced with these devices. Inclined plate separator capabilities have been demonstrated in numerous applications in this subcategory (Plant 0684F), in this industry, and in other industries.

Systems using a sulfide compound addition to the wastewater stream have been shown to be capable of reducing effluent metals concentrations to levels below those achieved with lime precipitation. Some of the toxic metals which can effectively be precipitated with sulfide are zinc, copper, nickel, lead, and silver. The increased removal efficiencies can be attributed to the comparative solubilities of metal sulfides and metal hydroxides. In general, the metal sulfides are less soluble than the respective metal hydroxides. However, it is important to note that an excess of sulfide in a treated effluent can result in objectionable odor problems. A decrease in wastewater pH will aggravate this problem, and if wastewater treatment pH control problems result in even a slightly acidic pH, operating personnel can be adversely affected. One method of controlling the presence of excess sulfide in the treated effluent involves using an iron sulfide slurry as the sulfide source. Ferrous sulfide will not readily dissociate in the waste stream, with the result that the free sulfide level is kept well below objectionable levels. However, the affinities of the other metals in the waste stream for sulfide are greater than that of iron, and consequently other metal sulfide precipitates are formed preferentially to iron sulfide. Once the sulfide requirements of the other metal precipitates are satisfied, the remaining sulfide remains as a ferrous precipitate and the excess iron from the sulfide is precipitated as a hydroxide. With the use of filtration following sulfide addition, additional toxic metal reductions can be achieved.

The Agency considered vapor compression distillation, in which a wastewater with a high dissolved solids content (the treatment system blowdown) is concentrated to a slurry consistency, as a possible means of attaining zero discharge in the steelmaking subcategories. The resulting slurry would be dried by various means while the distillate quality effluent would be recycled to the process. However, the

Agency excluded this technology from further consideration due to excessive costs and energy requirements.

Summary of Analytical Data

Raw wastewater and effluent analytical data for the basic oxygen furnace operations visited during the original and toxic pollutant surveys are presented in Tables VII-2 through VII-6. Similar data for the open hearth furnace and electric arc furnace operations are presented in Tables VII-7 through VII-9 and Tables VII-10 through VII-13, respectively. Plant AA, an electric arc furnace operation, was resampled as Plant 059A during the toxic pollutant survey. Table VII-1 presents the legend for the treatment technologies used in the above tables and in other tables throughout this report.

The concentrations presented in the above tables represent, except where footnoted, averages of measured values. In some cases, these data represent the values of central treatment systems. As indicated on the tables, the effluent waste loads (lb/1000 lb) for central treatment systems represent apportioned loads. In these central treatment systems, the percentage contribution of an individual operation to the total treatment system influent load was determined and subsequently applied to the total effluent load. This procedure was repeated for each pollutant. By using this procedure, an assessment was made of the effects of treatment on the waste loads of an individual process which discharges to a central treatment facility.

As a supplement to the sampled plant data, effluent data from plant D-DCP responses are presented in Tables VII-14 and VII-15 for the BOF operations, in Tables VII-16 and VII- 17 for open hearth operations, and in Table VII-18 for EAF operations. Tables VII-19 through VII-21 summarize the typical process wastewater characteristics for the various steelmaking processes as determined from the data noted above.

Plant Visits

Brief descriptions of the visited plants follow below, while treatment system flow schematics are presented at the end of this section.

A. Basic Oxygen Furnace - Semi-wet

Plant R (Figure VII-1)

Process wastewaters undergo sedimentation, with the aid of polymer addition, in a dragout tank. All wastewaters are recycled to the process.

Plant U (Figure VII-2)

A thickener and polymer addition are used to treat BOF wastewaters. The overflow from the thickener is discharged directly to a river with the exception of a side stream which is used for slag quenching. The thickener underflow is dewatered with a vacuum filter and the filtrate is returned to the thickener influent.

B. Basic Oxygen Furnace - Wet-Suppressed Combustion

Plant S (Figure VII-3)

This plant uses a classifier and thickener for primary and secondary suspended solids removal. The thickener underflow is dewatered using vacuum filtration. Ninety-five percent of the treated effluent is recycled while the remaining five percent is discharged.

Plant 032 (Figure VII-4)

Hydroclones and classifiers are used for primary solids removal in this wastewater treatment system. The effluent is then discharged to the thickener distribution box where it is mixed with the discharge from the secondary ventilation scrubbers. The thickener overflow, after pH adjustment, is recycled, from a holding tank, to the process. Seven percent of the thickener overflow is blowndown to a clarifier. The overflow from the clarifier is pumped to a central treatment facility and is subsequently discharged. The underflows from the thickeners and clarifier are discharged to settling lagoons.

Plant 034 (Figure VII-5)

Wastewaters from both Venturi scrubbers are combined in a distribution box. At this point polymer is added to aid in solids removal in a thickener. The thickener overflow is diverted to a holding tank where 96% of the thickener effluent is recycled to the process. The blowdown from the holding tank is clarified prior to discharge. The clarifier underflow is returned to the thickener influent while the thickener underflow is discharged to lagoons.

Plant 038 (Figure VII-6)

Wastewaters from the BOF quenchers are combined in a distribution box feeding two desiltors in which heavy solids are removed. The effluent from the desiltors is then discharged to two thickeners for secondary solids removal. Ninety-four percent of the thickener effluent is recycled to the system. The underflow from the thickeners is dewatered by vacuum filtration while the filtrate is returned to the inlet of the thickeners. The blowdown from the recycle system undergoes chemical flocculation and precipitation (with lime) and then sedimentation in "Lamella" separators. The effluent of the separators is discharged directly to the river while the underflow is returned to the thickeners.

C. Basic Oxygen Furnace - Wet-Open Combustion

Plant T (Figure VII-7)

A Grizzly, a cyclone and a classifier are used in this plant to accomplish primary solids removal. The effluent from these primary solids removal steps flows to a thickener where further solids removal is provided. The underflow from the thickener is transferred to sludge disposal. The overflow from the thickener flows to a holding tank. Seventy-six percent of the thickener effluent is recycled and the balance discharged. Industrial water is used as makeup to this process.

Plant V (Figure VII-8)

A classifier and thickener are used in this plant for primary and secondary suspended solids removal. Chemical addition is used to aid in secondary suspended solids removal. The thickener overflow is collected in a clearwell from which 87% of the thickener effluent is recycled. The remaining thirteen percent is discharged to a sewer. The thickener underflow is dewatered by vacuum filtration and the filtrate is returned to the thickener influent.

Plant 031 (Figure VII-9)

In this plant, spray wastewaters flow to a settling tank where primary suspended solids removal is accomplished. The overflow from this settling tank discharges into a dirty water sump where it is combined with Venturi scrubber water. This wastewater is then combined with other mill wastewaters in an equalization tank prior to chemical addition (lime and polymer) and clarification. The clarifier effluent is pumped to a final polishing lagoon which discharges directly to the river. The clarifier underflow is dewatered using vacuum filters and the filtrate is returned to the clarifier influent.

Plant 033 (Figure VII-10)

The wastewaters from the scrubber are discharged to a classifier for the purpose of achieving primary suspended solids removal. A portion of the classifier effluent is recycled to the process while the remaining (thirty percent) effluent flows to a thickener for secondary suspended solids removal. The overflow from the thickener is discharged. The thickener underflow is discharged to centrifuges for dewatering and the centrate is returned to the thickener influent.

Plant 035 - (Figure VII-11)

Wastewaters from the scrubbers and quenchers flow directly to a desiltor in which primary suspended solids removal is provided. The overflow from the desiltor is discharged to a clarifier for additional solids removal. Ninety percent of the clarifier effluent is recycled with the balance being discharged along with other plant wastewaters to a terminal treatment lagoon. The underflow from the clarifier is dewatered by vacuum filtration and the filtrate is returned to the clarifier inlet. Sludges from the desiltor and vacuum filter are further dewatered on drying beds.

Plant 036 (Figure VII-12)

BOF wastewaters are transferred to cyclones, where primary suspended solids removal is accomplished. The concentrated solids from the cyclones are discharged to classifiers where further solids concentration is accomplished. The overflow from the cyclones combined with the effluent from the classifiers make up the feed to the two thickeners. The overflow from the thickeners flows to a holding tank and then to the recycle tank. Overflows from the holding tank and recycle tank account for a blowdown of about 54%. The underflow from the thickeners flows to two centrifuges, the effluents of which are also discharged.

D. Open Hearth Furnace - Semi-wet

Plant 043 (Figure VII-13)

Each furnace has its own spray chamber which is manifolded to a central precipitator gas cleaning system. A common wastewater treatment system serves all of the spray chambers. The major component in the wastewater treatment system is a thickener. The thickener overflow is recycled, while a 0.3% blowdown is discharged to a final polishing lagoon. The thickener underflow is conveyed to a settling lagoon. The dry precipitator dust is slurried and removed from precipitator hoppers by pneumatic conveyors with water jet ejectors. This wastewater is discharged to another thickener. This thickener overflow is recycled to the water jet ejectors while the underflow is discharged to the settling lagoon.

E. Open Hearth Furnace - Wet

Plant W (Figure VII-14)

This gas cleaning system is a central system with manifolded ductwork which serves all of the furnaces in the shop. The central gas cleaning system is a parallel design of dry precipitators and wet scrubbers. The dry precipitators were installed first on the system and the Venturi scrubbers were added later. Each system is designed to clean approximately one half of the total gas volume from the open hearth shop.

The scrubber discharges empty into primary separators. A portion of the separator effluent is pumped to a thickener for final sedimentation, while the remaining effluent is combined with the thickener overflow in a recycle tank and returned to the Venturi scrubbers. Nine percent of the thickener overflow is discharged to a receiving stream.

Plant X (Figure VII-15)

This gas cleaning system is comprised of individual Venturi scrubbers for each open hearth furnace, although scrubber discharges are combined for treatment.

Wastewater treatment involves lime neutralization followed by sedimentation in a thickener. The thickener underflow is dewatered by vacuum filters and the filtrate is returned to the thickener inlet. Seventy-nine percent of the thickener overflow is recycled to the scrubbers. The remaining twenty-one percent is discharged to the plant sewer or treated further in a deep bed filter.

Plant 042 (Figure VII-16)

This gas cleaning system is a manifolded system in which all furnaces are exhausted through common ductwork to three clusters of hydroscrubbers, with each cluster being able to serve a set number of furnaces through the manifolded ductwork. The principle of the hydroscrubber involves the use of steam or air, and a water jet ejector for cleaning open hearth off-gases. Waste heat boilers furnish the steam for this process.

Wastewater treatment is provided in a joint system serving both the electric arc furnace shop and the open hearth shop. The wastewaters are neutralized, flocculated with polymers and then discharged to clarifiers where they undergo sedimentation. A portion of the clarifier overflow is recycled, while a 71% blowdown is discharged to final polishing lagoons. The clarifier underflow is dewatered by vacuum filters.

F. Electric Arc Furnace - Semi-wet

Plant V (Figure VII-17)

The wastewater treatment system provides for the treatment of scrubber discharges in a dragout tank, to which polymer is added. The only effluent from this system is a sludge which is collected in a sludge basin and then hauled away. The overflow from the dragout tank is completely recycled to the process.

Plant Z (Figure VII-18)

This plant closely controls the water spray of its gas cleaning system to produce a sludge of sufficient solids concentration to allow direct solids disposal. Solids captured by the gas cleaning system collect in water sealed tanks with drag-link conveyors. There is no aqueous discharge from this system.

Plant 059B (Figure VII-19)

This treatment system uses a clarifier to provide sedimentation for process wastewaters. The clarifier effluent is either reused in other operations in this plant or discharged, while the underflow is dewatered with vacuum filters.

G. Electric Arc Furnace - Wet

Plant AB (Figure VII-20)

Wastewaters from the Venturi scrubbers and primary quenchers are collected in a recirculation sump. Ninety-five percent of the wastewater in the sump is recirculated back to the scrubbers and quenchers. The remaining five percent flows to a thickener for sedimentation, and then to lagoons for final polishing prior to discharge. Vacuum filters dewater the sludge removed from the thickener.

Plant 051 (Figure VII-21)

Sedimentation is provided in a thickener. Vacuum filters are used to dewater the thickener underflow while the filtrate is returned to the inlet of the thickener. More than ninety-eight percent of the overflow is recycled to the scrubbers while the remainder is reused in other mill operations.

Plant 052 (Figure VII-22)

Open hearth and electric arc furnace wastewaters are co-treated in a combined treatment system. Systems of the EAF and open hearth shops discharge to a pump station which delivers the wastewaters to a flocculation and neutralization tank. Both lime and polymer are added prior to discharge to a clarifier. Vacuum filters dewater the clarifier underflow. Twenty-nine percent of the clarifier overflow is recycled back to the gas cleaning system, while the remaining seventy-one percent receives additional treatment in combined plant wastewater settling ponds.

Plant 059A (Figure VII-23)

Scrubber effluent wastewaters are discharged to conical bottom separator tanks. Most of the wastewater is recirculated to the scrubbers, while the remainder is discharged to clarifiers which provide further sedimentation. Approximately one half of the clarifier overflow is returned to the gas cleaning system while the other half is discharged to a settling pond.

TABLE VII-1

OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS

Symbols

A. Operating Modes

1. OT Once-Through

2. Rt,s,n Recycle, where t = type waste
s = stream recycled
n = % recycled

t: U = Untreated
T = Treated

	s	n
P	Process Wastewater	% of raw waste flow
F	Flume Only	% of raw waste flow
S	Flume and Sprays	% of raw waste flow
FC	Final Cooler	% of FC flow
BC	Barometric Cond.	% of BC flow
VS	Abs. Vent Scrub.	% of VS flow
FH	Fume Hood Scrub.	% of FH flow

3. REt,n Reuse, where t = type
n = % of raw waste flow

t: U = before treatment
T = after treatment

4. BDn Blowdown, where n = discharge as % of raw waste flow

B. Control Technology

10. DI Deionization

11. SR Spray/Fog Rinse

12. CC Countercurrent Rinse

13. DR Drag-out Recovery

C. Disposal Methods

20. H Haul Off-Site

21. DW Deep Well Injection

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 2

C. Disposal Methods (cont.)

22.	Qt,d	Coke Quenching, where t = type d = discharge as % of makeup t: DW = Dirty Water CW = Clean Water
23.	EME	Evaporation, Multiple Effect
24.	ES	Evaporation on Slag
25.	EVC	Evaporation, Vapor Compression Distillation

D. Treatment Technology

30.	SC	Segregated Collection
31.	E	Equalization/Blending
32.	Scr	Screening
33.	OB	Oil Collecting Baffle
34.	SS	Surface Skimming (oil, etc.)
35.	PSP	Primary Scale Pit
36.	SSP	Secondary Scale Pit
37.	EB	Emulsion Breaking
38.	A	Acidification
39.	AO	Air Oxidation
40.	GF	Gas Flotation
41.	M	Mixing
42.	Nt	Neutralization, where t = type t: L = Lime C = Caustic A = Acid W = Wastes O = Other, footnote

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 3

D. Treatment Technology (cont.)

43. FLt Flocculation, where t = type

t: L = Lime
A = Alum
P = Polymer
M = Magnetic
O = Other, footnote

44. CY Cyclone/Centrifuge/Classifier

44a. DT Drag Tank

45. CL Clarifier

46. T Thickener

47. TP Tube/Plate Settler

48. SLn Settling Lagoon, where n = days of retention time

49. BL Bottom Liner

50. VF Vacuum Filtration (of e.g., CL, T, or TP underflows)

51. Ft,m,h Filtration, where t = type
m = media
h = head

t	m	h
D = Deep Bed	S = Sand	G = Gravity
F = Flat Bed	O = Other, footnote	P = Pressure

52. CLt Chlorination, where t = type

t: A = Alkaline
B = Breakpoint

53. CO Chemical Oxidation (other than CLA or CLB)

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT
TECHNOLOGIES AND DISPOSAL METHODS
PAGE 4

D. Treatment Technology (cont.)

54.	BOt	Biological Oxidation, where t = type t: An = Activated Sludge n = No. of Stages T = Trickling Filter B = Biodisc O = Other, footnote
55.	CR	Chemical Reduction (e.g., chromium)
56.	DP	Dephenolizer
57.	ASt	Ammonia Stripping, where t = type t: F = Free L = Lime C = Caustic
58.	APt	Ammonia Product, where t = type t: S = Sulfate N = Nitric Acid A = Anhydrous P = Phosphate H = Hydroxide O = Other, footnote
59.	DSt	Desulfurization, where t = type t: Q = Qualifying N = Nonqualifying
60.	CT	Cooling Tower
61.	AR	Acid Regeneration
62.	AU	Acid Recovery and Reuse
63.	ACt	Activated Carbon, where t = type t: P = Powdered G = Granular
64.	IX	Ion Exchange
65.	RO	Reverse Osmosis
66.	D	Distillation

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT
TECHNOLOGIES AND DISPOSAL METHODS
PAGE 5

D. Treatment Technology (cont.)

67.	AA1	Activated Alumina
68.	OZ	Ozonation
69.	UV	Ultraviolet Radiation
70.	CNTt,n	Central Treatment, where t = type n = process flow as % of total flow t: 1 = Same Subcats. 2 = Similar Subcats. 3 = Synergistic Subcats. 4 = Cooling Water 5 = Incompatible Subcats.
71.	On	Other, where n = Footnote number
72.	SB	Settling Basin
73.	AE	Aeration
74.	PS	Precipitation with Sulfide

TABLE VII-2

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
BASIC OXYGEN FURNACE - SEMI-WET

Raw Wastewaters

Reference Code	0432A		0396D		Average	
Plant Code	R		U			
Sample Points	#1		#1			
Flow, gal/ton	130		728		429	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	235	0.176	418	1.27	372	0.723
Fluoride	NR	NR	3.1	0.00940	3.1	0.00940
pH (Units)	11.2		11.8		11.2-11.8	
120 Copper	0.05	0.000027	0.03	0.000091	0.04	0.000059
122 Lead	1.8	0.000970	1.0	0.00303	1.4	0.00200
123 Mercury	0.0042	0.000002	0.001	0.000030	0.0026	0.000016
129 Zinc	1.01	0.000546	1.08	0.00328	1.04	0.00191

Effluent

Reference Code	0432A		0396D	
Plant Code	R		U	
Sample Points	#2		#2	
Flow, gal/ton	0		728	
C&TT	Settling tank, FLP, RTP 100		T,FLP,OT	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	125	0	38	0.115
Fluoride	NR	NR	3.8	0.0115
pH (Units)	11.3		11.9	
120 Copper	0.02	0	#	#
122 Lead	0.53	0	1.0	0.00303
123 Mercury	0.0023	0	0.0027	0.000008
128 Zinc	0.32	0	1.6	0.00485

NR: Value not Reported
: Values for Determination are Qualified

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-3

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

Raw Wastewaters

Reference Code	0060
Plant Code	S
Sample Points	#1
Flow, gal/ton	982

	mg/l		lbs/10000 lbs
Suspended Solids	359		1.47
Fluoride	NR		NR
pH (Units)		8.8	
122 Lead	3.52		0.0144
128 Zinc	17		0.0696

Effluent

Reference Code	0060
Plant Code	S
Sample Points	#2
Flow, gal/ton	52
C&TT	Classifier, T,FLP,VF, RTP94.7

	mg/l		lbs/1000 lbs
Suspended Solids	22		0.00478
Fluoride	NR		NR
pH (Units)		9.3	
122 Lead	0.12		0.0000261
128 Zinc	0.9		0.000196

NR: Not Reported

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-4

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

Raw Wastewaters

Reference Code	0384A		0856N		0684F		Average		Overall Average[1]	
Plant Code	032		034		038					
Sample Points	B+C+D		B		B					
Flow, gal/ton	1470		1150		569		1060		1043	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	1468	8.97	381	1.82	674	1.6	841	4.13	720	3.46
Fluoride	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
pH (Units)	8.7		9.4		11.3		8.7-11.3		8.7-11.3	
118 Cadmium	0.098	0.00060	NR	NR	0.040	0.00009	0.069	0.00035	0.069	0.00035
119 Chromium	1.06	0.00646	NR	NR	0.167	0.00040	0.612	0.00343	0.612	0.00343
120 Copper	0.321	0.00196	0.080	0.00038	0.073	0.00017	0.237	0.0008	0.237	0.0008
122 Lead	26.8	0.164	1.50	0.0072	0.234	0.00055	9.5	0.057	8.0	0.047
124 Nickel	0.338	0.00206	0.546	0.00261	0.032	0.00008	0.305	0.0016	0.305	0.0016
126 Silver	0.030	0.00018	NR	NR	0.016	0.00004	0.023	0.00011	0.023	0.00011
128 Zinc	8.42	0.0515	0.611	0.00292	1.17	0.00277	3.401	0.0191	6.80	0.0317

Effluent

Reference Code	0384A		0856N		0684F	
Plant Code	032		034		038	
Sample Points	H		D		D	
Flow, gal/ton	98		47		33	
C&TT	Classifier,T,CL, RTP 93		T,CL,FLP, RTP 96		Desiltors,T,VF, TP,FLP,FLL, RTP 94.2	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	55	0.0224	47	0.00920	13	0.00177
Fluoride	NR	NR	NR	NR	NR	NR
pH	8.8		10.0		7.5	
118 Cadmium	0.008	0.000003	NR	NR	0.010	0.000001
119 Chromium	0.013	0.000005	NR	NR	0.010	0.000001
120 Copper	0.009	0.000003	0.10	0.000020	0.010	0.000001
122 Lead	0.468	0.00019	0.82	0.00016	NR	NR
124 Nickel	0.010	0.000004	0.69	0.00014	0.010	0.000001
126 Silver	0.015	0.000006	NR	NR	0.010	0.000001
128 Zinc	0.227	0.000093	0.28	0.000055	0.10	0.000014

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(1) Average of all values on Tables VII-3 and VII-4.
NR : Not Reported.
NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-5

SUMMARY OF ANALYTICAL DATA FROM PLANTS SAMPLED
ORIGINAL GUIDELINES SURVEY
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

Raw Wastewaters

Reference Code	0112A		0584F		Averages	
Plant Code	T		V			
Sample Points	#1		#5			
Flow, gal/ton	633		259		446	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	3812	10.1	5375	5.80	4594	7.9
Fluoride	26	0.0686	+	+	26	0.0686
pH	8.0		3.4		3.4-8.0	
120 Copper	2.4	0.00633	+	+	2.4	0.00633
123 Mercury	0.0031	0.000008	0.0016	0.000002	0.0023	0.000005
128 Zinc	6.0	0.0158	195	0.211	100	0.1134

Effluent

Reference Code	0112A		0584F	
Plant Code	T		V	
Sample Points	#2		#6	
Flow, gal/ton	150		33	
C&TT	Classifier,T,FLP,RTP76		Classifier,T,FLP,RTP87	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	81	.0506	40	0.00551
Fluoride	20	0.0125	NR	NR
pH (units)	9.4		6.4	
120 Copper	0.12	0.000075	+	+
123 Mercury	0.0013	0.000001	0.0012	0.000000
128 Zinc	0.50	0.000313	2.8	0.000386

NR: Not Reported
+ : Cannot be evaluated

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-6

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

Raw Wastewaters

Reference Code	0020B		0856B		0868A		0112D		Averages		Overall Averages(1)	
Plant Code	031		033		035		036					
Sample Points	B		C		A		O					
Flow, (gal/ton)	1059		241		1046		454		717		626	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	409	1.80	7769	7.79	922	40.2	7087	13.4	4047	6.75	4229	7.15
Fluoride	NR	NR	NR	NR	NR	NR	8.5	0.015	8.5	0.015	17.2	0.0418
pH (units)	8.1		11.7		8.4		11.3		8.1-11.7		3.4-11.7	
23 Chloroform	0.052	0.00023	0.013	0.000013	0.056	0.00025	0.053	0.00010	0.044	0.00015	0.044	0.00015
115 Arsenic	0.054	0.00024	0.075	0.000075	NR	NR	NR	NR	0.064	0.00016	0.064	0.00016
118 Cadmium	0.291	0.00128	1.80	0.00181	0.021	0.000091	0.174	0.000329	0.572	0.00109	0.572	0.00109
119 Chromium	17.4	0.0766	2.95	0.00297	0.024	0.000105	0.367	0.000694	5.19	0.0201	5.19	0.0201
120 Copper	1.21	0.00535	0.924	0.000928	0.021	0.000091	0.334	0.000632	0.622	0.00175	0.978	0.00267
122 Lead	1.74	0.00766	13.6	0.0137	0.041	0.000179	0.367	0.000694	3.94	0.00556	3.94	0.00556
123 Mercury	0.034	0.00015	0.0001	0.000000	0.0005	0.000002	0.0335	0.000063	0.0170	0.000054	0.021	0.000038
124 Nickel	1.00	0.00442	0.712	0.000715	0.005	0.000022	0.047	0.000089	0.441	0.00131	0.441	0.00131
125 Selenium	0.008	0.00004	0.037	0.000037	NR	NR	NR	NR	0.022	0.000038	0.022	0.000038
126 Silver	0.501	0.00221	0.182	0.000182	0.001	0.00004	0.043	0.000081	0.182	0.00619	0.182	0.00619
127 Thallium	0.080	0.00035	0.130	0.000130	NR	NR	NR	NR	0.105	0.000240	0.105	0.000240
128 Zinc	3.34	0.0147	49.1	0.0493	3.79	0.0165	2.00	0.00379	14.6	0.0211	43.2	0.0518

TABLE VII-6
SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION
PAGE 2

	Effluent							
Reference Code	0020B		0856B		0868A		0112D	
Plant Code	031		033		035		036	
Sample Points	(B/B+C)D		D		M		P	
Flow, gal/ton	1059		241		113		244	
C&TT	DR,ET, FLL,FLP,CL,SL,VF,OT		Classifier,CY,T, CT,RUP(UNK)		Desiltor,CL,VF, RTP90		CY,T,CT, RTP46	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	19	0.05	52	0.052	47	0.022	1,242	1.27
Fluoride	9.0	NR	NR	NR	NR	NR	4.4	0.004
pH (units)	7.9		11.6		8.6		11.9	
23 Chloroform	0.089	0.00055	0.022	0.00002	0.015	0.00001	0.122	0.00012
115 Arsenic	0.006	0.00001	0.017	0.00002	NR	NR	NR	NR
118 Cadmium	0.488	0.00152	NR	NR	0.010	0.00001	0.010	0.00001
119 Chromium	1.04	0.0122	30.1	0.0302	0.009	0.00001	0.04	0.00004
120 Copper	0.476	0.00135	0.069	0.00007	0.009	0.00001	0.364	0.00037
122 Lead	0.455	0.00015	0.942	0.00095	NR	NR	0.155	0.00016
123 Mercury	0.0001	0.00000	0.0001	0.0000	0.0003	0.00000	0.0001	0.00000
124 Nickel	1.05	NR	2.02	0.00203	0.010	0.00001	0.010	0.00001
125 Selenium	0.008	0.00000	0.031	0.00003	NR	NR	NR	NR
126 Silver	# (NR)	NR	NR	NR	0.010	0.00001	0.339	0.00035
127 Thallium	0.060	0.00036	0.080	0.00008	NR	NR	NR	NR
128 Zinc	2.14	0.00050	0.317	0.00032	0.706	0.00033	0.706	0.00072

---

(1) Average of all values on Tables VII-5 and VII-6.

NR: Not reported
#: Values for determination are qualified

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-7

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
OPEN HEARTH FURNACE - SEMI-WET

Raw Wastewaters

Reference Code	0864A
Plant Code	043
Sample Points	B
Flow, gal/ton	1163

	mg/l	lbs/1000 lbs
Suspended Solids	511	2.48
Fluoride	255	1.24
pH (units)	2.7	
119 Chromium	0.080	0.000388
120 Copper	0.083	0.000402
121 Cyanides	0.039	0.00019
124 Nickel	0.053	0.00026
128 Zinc	0.500	0.00242

Effluent*

Reference Code	0864A
Plant Code	043
Sample Points	C
Flow, Gal/Ton	3.7
C&TT	CL,FLL,FLP,RTP 99.7

	mg/l	lbs/1000 lbs
Suspended Solids	30	0.00046
Fluoride	32	0.00049
pH (units)	10.8	
119 Chromium	0.010	0.000000
120 Copper	0.013	0.000000
121 Cyanide	0.006	0.000000
124 Nickel	0.009	0.000000
128 Zinc	0.07	0.000001

---

*: The effluent quality data was considered as the clarifier overflow, although the blowdown undergoes further treatment, along with other wastewaters, in a terminal treatment lagoon. This was done because the clarifier overflow is more indicative of the effluent from the open hearth treatment system and does not include the pollutant contributions of other sources.

NOTE: For a definition of the C&TT codes, refer to Table VII-1.

TABLE VII-8

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
OPEN HEARTH FURNACE - WET

Raw Wastewaters

Reference Code	0112A		0060		**Averages**	
Plant Code	W		X			
Sample Points	#1		#1			
Flow, Gal/Ton	607		550		578	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	779	1.97	3994	9.15	2387	5.56
Fluoride	161	0.407	67	0.15	114	1.36
pH (Units)	3.7		6.2		3.7-6.2	
120 Copper	0.52	0.0013	3.6	0.0082	2.1	0.0048
122 Lead	0.6	0.002	NR	NR	0.6	0.002
128 Zinc	27	0.068	*	*	27	0.068

Effluent

Reference Code	0112A		0060	
Plant Code	W		X	
Sample Point(s)	#3		#2	
Flow, Gal/Ton	51.4		118	
C&TT	T, RTP 46, RUP 45		T, FLL, VF, RTP 79	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	80	0.017	52	0.026
Fluoride	148	0.0317	65	0.032
pH (Units)	2.6		6.1	
120 Copper	0.40	0.000086	0.21	0.00010
122 Lead	0.21	0.000045	NR	NR
128 Zinc	26	0.0056	*	*

NR: No value was reported.
* : A representative sample could not be obtained.

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-9

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
OPEN HEARTH FURNACE - WET

Raw Wastewaters

	Reference Code	0492A			
	Plant Code	042		Overall Average(1)	
	Sample Points	C			
	Flow, Gal/Ton	506		554	
		mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
	Suspended Solids	1519	3.20	2097	4.77
	Fluoride	101	0.212	110	0.256
	pH (Units)	6.7		3.7-6.7	
128	Zinc	391	0.823	209	0.446

Effluent*

	Reference Code	0492A	
	Plant Code	042	
	Sample Points	(C/B + C)D	
	Flow, Gal/Ton	359	
	C&TT	CL, NL, FLP, VF, RTP 67	
		mg/l	lbs/1000 lbs
	Suspended Solids	15	0.036
	Fluoride	27	0.074
	pH (Units)	9.1	
128	Zinc	4.4	0.013

---

(1) Average of all values on Tables VII-8 and VII-9.

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-10

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
ELECTRIC ARC FURNACE - SEMI-WET

Raw Wastewater

	Reference Code	0432C		0584A			
	Plant Code	Y		Z			
	Sample Points	#1		NA		Average	
	Flow, Gal/Ton	97		NA		97	
		mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
	Suspended Solids	2165	0.884	*	*	2165	0.884
	Fluoride	30	0.012	*	*	30	0.012
	pH (units)	7.8				7.8	
120	Copper	2.40	0.000979	*	*	2.40	0.000979
122	Lead	32.9	0.0134	*	*	32.9	0.0134
128	Zinc	125	0.510	*	*	125	0.510

Effluent

	Reference Code	0432C		0584A	
	Plant Code	Y		Z	
	Sample Points	#2		NA	
	Flow, Gal/Ton	0		0	
	C&TT Code	DR,FLP,RTP 100		DR,RTP 100	
		mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
	Suspended Solids	528	0	*	0
	Fluoride	28	0	*	0
	pH (units)	6.7		*	
120	Copper	0.96	0	*	0
122	Lead	8.5	0	*	0
128	Zinc	53.3	0	*	0

---

*: No samples of the raw or treated wastewaters could be collected during the survey, however, this plant was confirmed as having a closed system with no wastewater discharge.

NOTE: For definition of C&TT Codes, refer to Table VII-1.

TABLE VII-11

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
ELECTRIC ARC FURNACE - SEMI-WET

Raw Wastewater

Reference Code	0060F			
Plant Code	059B		Overall Average (1)	
Sample Points	K-O-H			
Flow, Gal/Ton	23.7		60.4	
	mg/l	lb/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	192,300	16.6	97.230	8.74
Fluoride	2210	0.191	1120	0.102
pH (units)	*		7.8	
120 Copper	NR	NR	2.40	0.000979
122 Lead	NR	NR	32.9	0.0134
128 Zinc	833	0.0719	479	0.290

Effluent

Reference Code	0060F	
Plant Code	059B	
Sample Points	$\frac{\text{K-O-H}}{\text{K}}$ L	
Flow, Gal/Ton	20.6	
C&TT	CL,VF,OT,RET(Unk)	
	mg/l	lb/1000 lbs
Suspended Solids	119	0.039
Fluoride	64	0.020
pH (Units)	8.1	
120 Copper	NR	NR
122 Lead	NR	NR
128 Zinc	3.3	0.00078

---

(1) Average of all values on Tables VII-10 and VII-11.

* : A representative sample could not be obtained.
NR: Not Reported

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-12

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
ELECTRIC ARC FURNACE - WET

Raw Wastewater

Reference Code	0868B
Plant Code	AB
Sample Point(s)	#2-#11
Flow, Gal/Ton	3060

	mg/l		lbs/1000 lbs
Suspended Solids	*		*
Fluoride	*		*
pH (Units)		*	
120 Copper	*		*
122 Lead	*		*
128 Zinc	*		*

Effluent

Reference Code	0868B
Plant Code	AB
Sample Point(s)	#4
Flow, Gal/Ton	162
C&TT	T,VF,SL,RTP95

	mg/l		lbs/1000 lbs
Suspended Solids	148		0.0999
Fluoride	12		0.0081
pH (Units)		7.8	
120 Copper	0.59		0.00040
122 Lead	1.0		0.00068
128 Zinc	3.2		0.0022

---

*: A representative sample of the raw waste could not be obtained.

NOTE: For a definition of the C&TT codes, refer to Table VII-1.

TABLE VII-13

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
ELECTRIC ARC FURNACE - WET

Raw Wastewater

Reference Code	0612		0492A		0060F		Average		Overall Average(2)	
Plant Code	051		052		059A					
Sample Points	B-D		B		F					
Flow, Gal/Ton	1141(1)		1178		2300		1540		1920	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	2843	13.5	885	4.34	6320	60.6	3349	26.1	3349	26.1
Fluoride	NR	NR	30	0.15	49	0.47	40	0.031	40	0.031
pH (units)	7.1		8.9		7.1		7.1-9.0		7.1-9.0	
4 Benzene	0.010	0.000047	0.007	0.00003	0.025	0.00024	0.014	0.00011	0.014	0.00011
39 Fluoranthene	0.003	0.000014	0	0	0.058	0.00056	0.020	0.00019	0.020	0.00019
58 4-Nitrophenol	0.007	0.000033	0	0	0.031	0.00030	0.013	0.00011	0.013	0.00011
64 Pentachlorophenol	0.003	0.000014	0	0	0.040	0.008	0.014	0.00013	0.014	0.00013
84 Pyrene	0.003	0.000014	0	0	0.053	0.00051	0.019	0.00017	0.019	0.00017
114 Antimony	0.671	0.00318	NR	NR	NR	NR	0.67	0.00318	0.67	0.00318
115 Arsenic	1.23	0.00586	NR	NR	NR	NR	1.23	0.00586	1.23	0.00586
118 Cadmium	3.33	0.0158	NR	NR	NR	NR	3.33	0.0158	3.33	0.0158
119 Chromium	4.31	0.0205	NR	NR	NR	NR	4.3	0.0205	4.31	0.205
120 Copper	1.33	0.000633	NR	NR	NR	NR	1.33	0.00633	1.33	0.00633
122 Lead	23.3	0.111	NR	NR	NR	NR	233	0.111	23.3	0.111
124 Nickel	0.043	0.000204	NR	NR	NR	NR	0.043	0.000204	0.043	0.000204
126 Silver	0.063	0.000299	NR	NR	NR	NR	0.063	0.000299	0.063	0.000299
128 Zinc	100	0.475	2.00	0.00982	190	1.82	97.3	0.768	97.3	0.768

TABLE VII-13
SUMMARY OF ANALTYICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
ELECTRIC ARC FURNACE - WET
PAGE 2

			Effluents			
Reference Code	0612		0492A		0060F	
Plant Code	051		052		059A	
Sample Points	E		$\frac{B}{(B+C)}$ D		G	
Flow, gal/ton	17.3		836		238	
C&TT	CL,T,VF,RTP98.5		CL,FLP,NL,VF,RTP29		CL,VF,RTP&RUP89.7	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	86	0.00621	15	0.0488	38	0.038
Fluoride	NR	NR	27	0.049	34	0.034
pH (Units)	7.6		9.1		7.4	
4 Benzene	0.028	0.000002	0.007	0.000034	0.012	0.000012
39 Fluoranthene	0.005	0.000000	0	0	0.010	0.000010
58 4-Nitrophenol	0	0	0	0	0	0
64 Pentachlorophenol	0	0	0	0	0.014	0.000014
84 Pyrene	0.005	0.000000	0	0	0.15	0.00015
114 Antimony	0.006	0.000000	NR	NR	NR	NR
115 Arsenic	0.011	0.000001	NR	NR	NR	NR
118 Cadmium	1.50	0.000108	NR	NR	NR	NR
119 Chromium	0.55	0.000040	NR	NR	NR	NR
120 Copper	0.080	0.000006	NR	NR	NR	NR
122 Lead	1.50	0.000108	NR	NR	NR	NR
124 Nickel	0.005	0.000000	NR	NR	NR	NR
126 Silver	0.001	0.000000	NR	NR	NR	NR
128 Zinc	20	0.00144	4.4	0.00205	38	0.038

---

(1) Applied flow does not include 22 GPT which is evaporated at the quencher.
(2) Average of all values on Tables VII-12 and VII-13.

NR: Not Reported

NOTE: For a definition of C&TT codes, refer to Table VII-1.

TABLE VII-14

ANALYSIS OF D-DCP ANALYTICAL DATA
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

Parameter	Plant 0384A No. of Analyses	Plant 0384A Avg.	Plant 0384A Max.	Plant 0384A Std. Dev.	Plant 0856N No. of Analyses	Plant 0856N Avg.	Plant 0856N Max.	Plant 0856N Std. Dev.
Suspended Solids	75	16	47	9	3	34	43	8.2
Fluoride	*				3	38.3	40	1.53
pH (Units)	76	9.3	10.3	NA	3	7.93	9.95	NA
118 Cadmium	*				3	ND	0.005	ND
119 Chromium	*				3	ND	0.010	ND
120 Copper	*				3	0.008	0.014	0.005
122 Lead	*				3	0.070	0.110	0.037
124 Nickel	*				3	ND	0.010	ND
126 Silver	*				3	ND	0.005	ND
128 Zinc	*				3	0.036	0.048	0.012

---

* : No data provided.
ND: Not detected, i.e., below the limits of detection.
NA: Not Applicable

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE VII-15

ANALYSIS OF D-DCP ANALYTICAL DATA
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

	Plant 0020B				Plant 0860B			
Parameter	No. of Analyses	Avg.	Max.	Std. Dev.	No. of Analyses	Avg.	Max.	Std. Dev.
Suspended Solids	106	41.1	1310	127.6	*			
Fluoride	106	20.2	44	7.6	*			
pH (Units)	120	7.5	9.5	NA	5	9.6	10.4	NA
119 Chromium	99	0.083	1.55	0.172	*			

---

*: No data provided
NA: Not Applicable

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE VII-16

ANALYSIS OF D-DCP ANALYTICAL DATA
OPEN HEARTH FURNACE - SEMI-WET

Parameters		Plant 0864A	
		No. of Analyses	Value
	Suspended Solids	1	36
	Fluoride	1	22.5
	pH (Units)	1	10.0
119	Chromium	1	0.020
120	Copper	1	0.023
121	Cyanide	1	0.031
124	Nickel	1	0.040
128	Zinc	1	0.050

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE VII-17

ANALYSIS OF D-DCP ANALYTICAL DATA
OPEN HEARTH FURNACE - WET

	Plant 0112A			
Parameters	**No. of Analyses**	**Avg.**	**Max.**	**Std. Dev.**
Suspended Solids (mg/l)	16	163	455	109.5

TABLE VII-18

ANALYSIS OF D-DCP ANALYTICAL DATA ELECTRIC ARC FURNACE - WET

Parameters	Plant 0060D				Plant 0612		Plant 0868B			
	No. of Analyses	Avg.	Max.	Std. Dev.	No. of Analyses	Value	No. of Analyses	Avg.	Max.	Std. Dev.
Suspended Solids	18	54.1	84	18.7	1	62	*			
Fluoride	20	22.7	42	9.8	*		*			
pH (Units)	20	7.0-9.0		NA	1	6.8	*			
115 Arsenic	*				*		1	<0.02	NA	NA
118 Cadmium	*				1	3.0	1	<0.02	NA	NA
119 Chromium	19	1.9	6.3	1.5	1	0.32	1	<0.01	NA	NA
120 Copper	*				1	0.11	1	<0.01	NA	NA
122 Lead	*				1	2.5	1	0.06	NA	NA
124 Nickel	*				1	0.09	1	<0.1	NA	NA
126 Silver	*				*		2	0.015	0.02	0.002
128 Zinc	*				1	48	2	0.145	0.17	0.036

---

*: No data provided.
NA: Not Applicable

NOTE: All values are expressed in mg/l unless otherwise noted.

TABLE VII-19

RAW WASTEWATER CHARACTERIZATION
BASIC OXYGEN FURNACE

(All values are expressed in mg/l unless otherwise noted)

	Parameters	Concentrations
Semi-Wet		
	Suspended Solids	375
	Fluoride	10
	pH (Units)	10-12
120	Copper	0.040
122	Lead	1.5
123	Mercury	0.003
128	Zinc	1.0
Wet-Suppressed Combustion		
	Suspended Solids	1500
	Fluoride	15
	pH (Units)	8-11
118	Cadmium	0.10
119	Chromium	0.50
120	Copper	0.25
122	Lead	15.00
124	Nickel	0.50
126	Silver	0.025
128	Zinc	5.00
Wet-Open Combustion		
	Suspended Solids	4200
	Fluoride	15
	pH (Units)	8-11
23	Chloroform	0.05
115	Arsenic	0.05
118	Cadmium	0.50
119	Chromium	5.00
120	Copper	0.50
122	Lead	1.00
123	Mercury	0.01
124	Nickel	0.50
125	Selenium	0.025
126	Silver	0.20
127	Thallium	0.10
128	Zinc	5.00

TABLE VII-20

RAW WASTEWATER CHARACTERIZATION
OPEN HEARTH FURNACE

(All values expressed in mg/l unless otherwise noted)

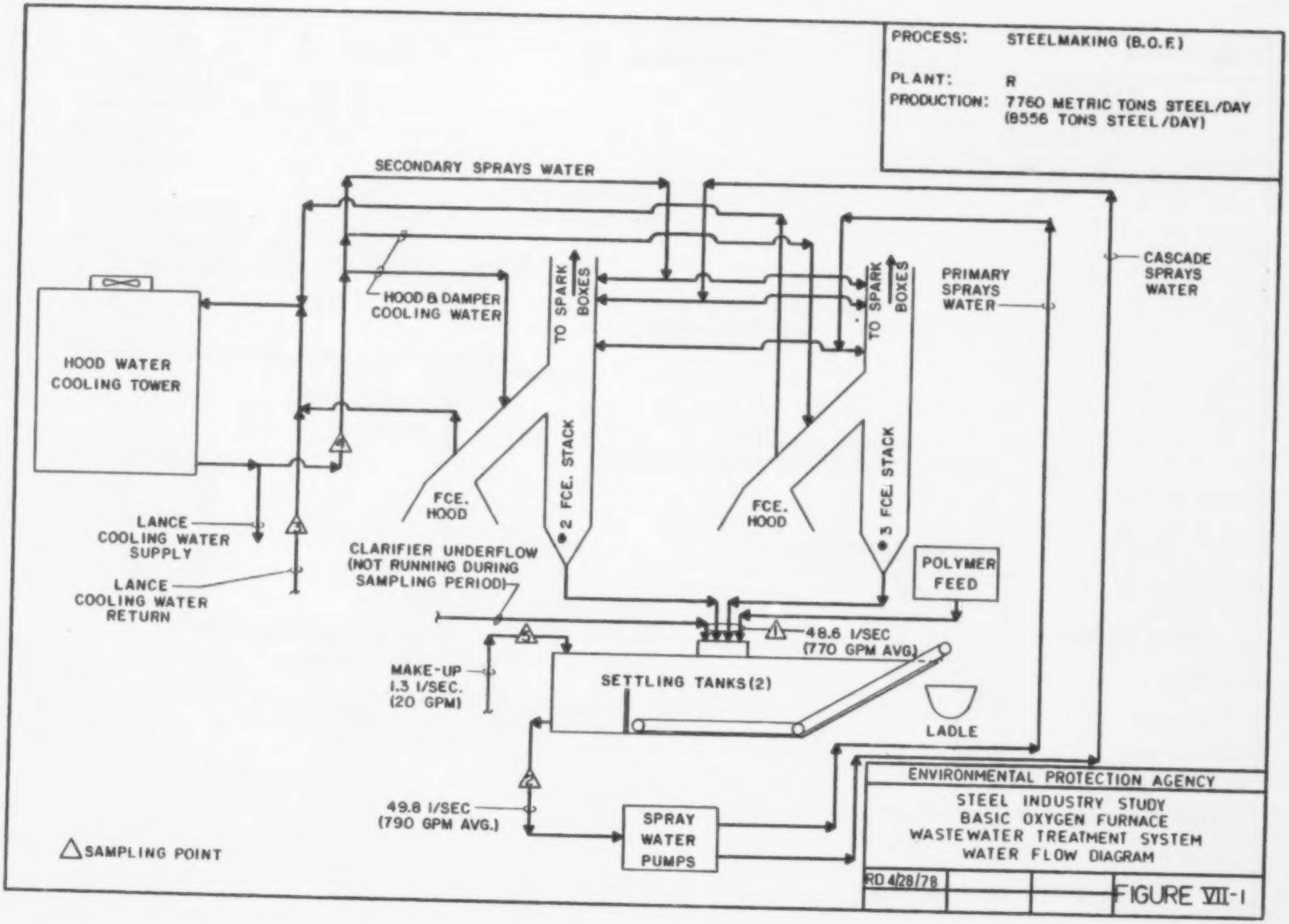
	Parameters	Concentrations
Semi-Wet		
	Suspended Solids	500
	Fluoride	260
	pH (Units)	2-3
119	Chromium	0.80
120	Copper	0.80
121	Cyanide	0.040
124	Nickel	0.05
128	Zinc	0.50
Wet		
	Suspended Solids	1100
	Fluoride	110
	pH (Units)	3-7
120	Copper	2.0
122	Lead	0.60
128	Zinc	200

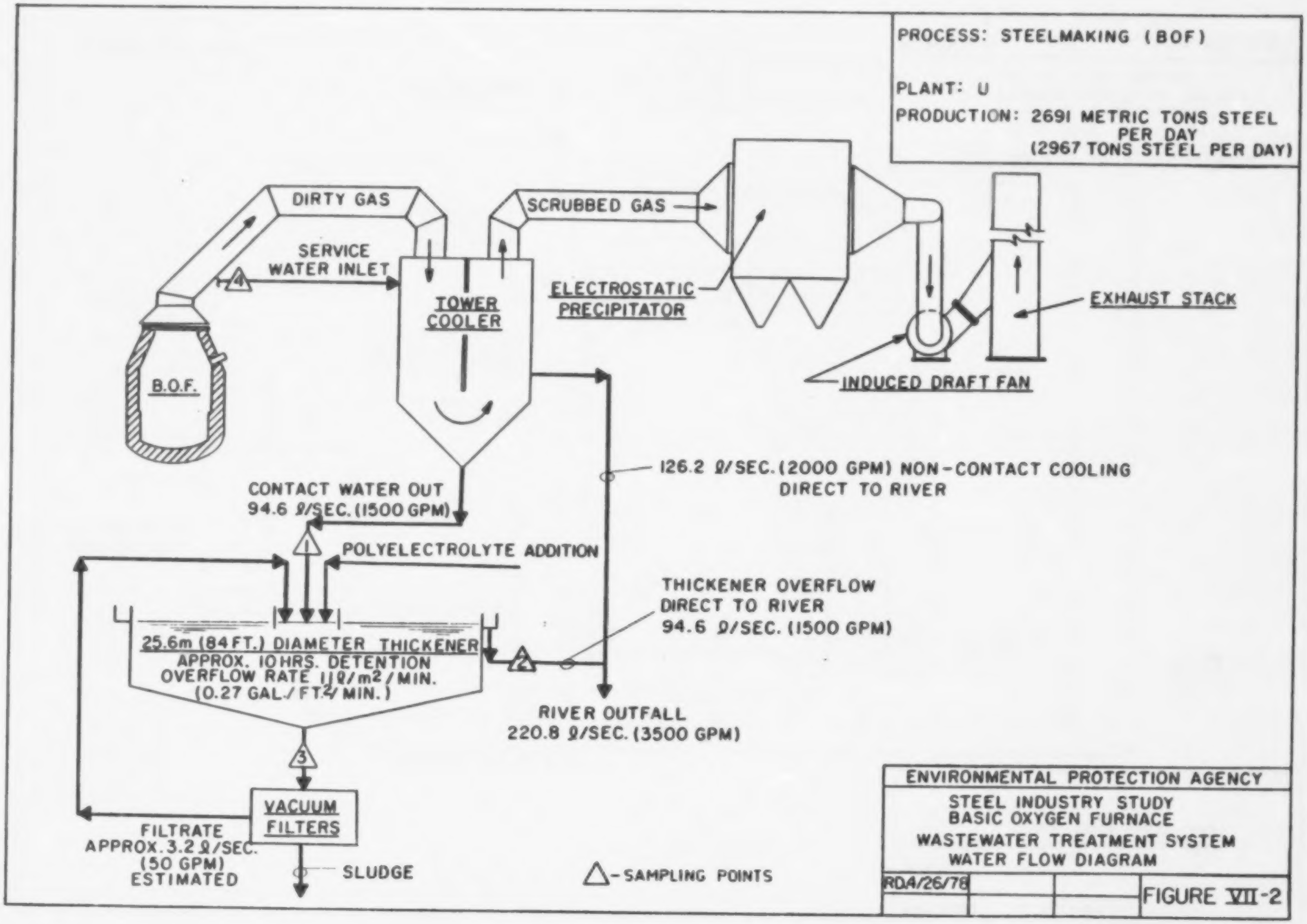
TABLE VII-21

RAW WASTEWATER CHARACTERIZATION
ELECTRIC ARC FURNACE

(All values are expressed in mg/l unless otherwise noted)

	Parameters	Concentrations
Semi-Wet		
	Suspended Solids	2200
	Fluoride	30
	pH (Units)	6-9
120	Copper	2
122	Lead	30
128	Zinc	125
Wet		
	Suspended Solids	3400
	Fluoride	50
	pH (Units)	6-9
4	Benzene	0.015
39	Fluoranthene	0.020
58	4-Nitrophenol	0.015
64	Pentachlorophenol	0.015
84	Pyrene	0.020
114	Antimony	0.70
115	Arsenic	2.0
118	Cadmium	4.0
119	Chromium	5.0
120	Copper	2.0
122	Lead	30.0
124	Nickel	0.050
126	Silver	0.060
128	Zinc	125

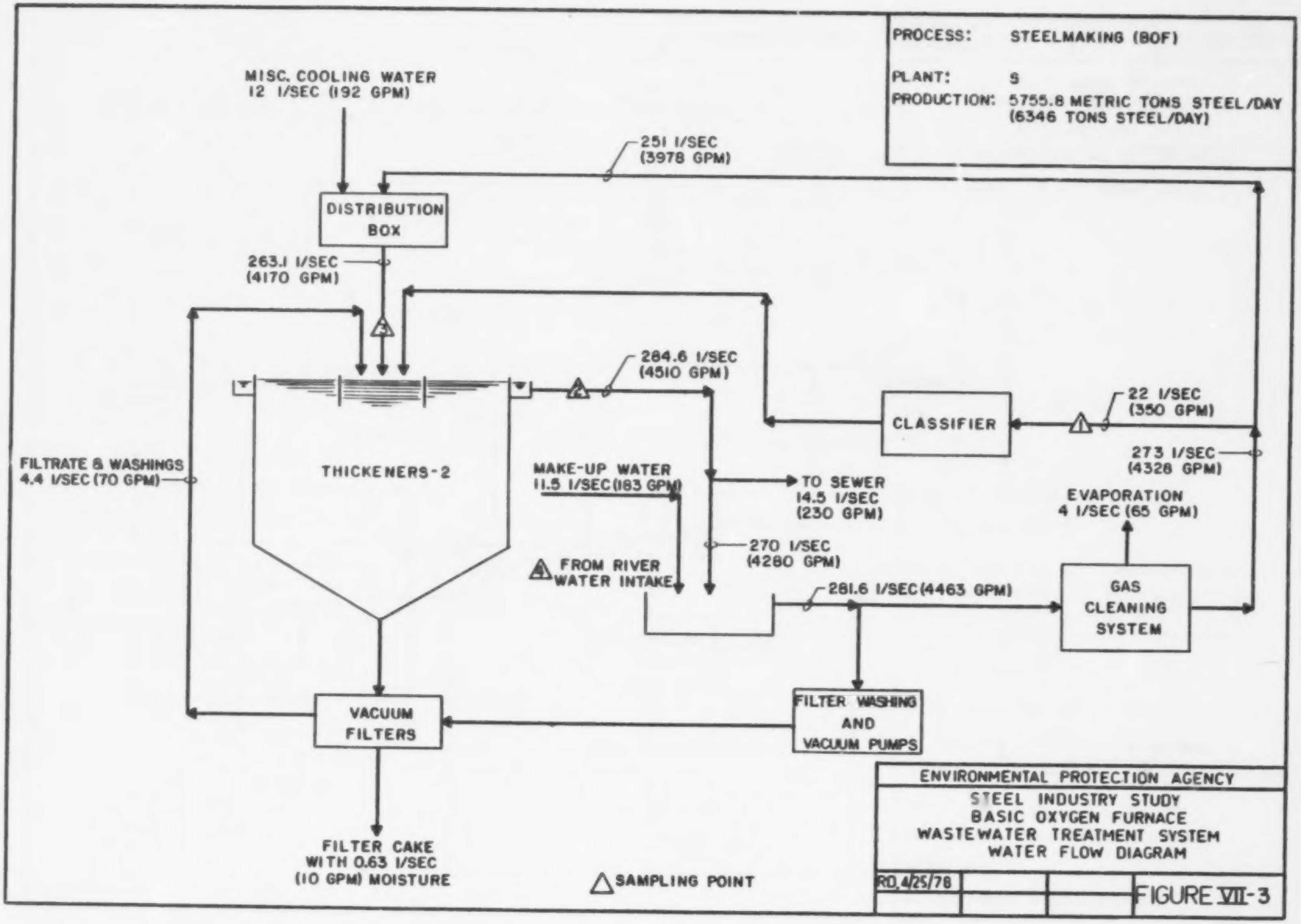

PROCESS: STEELMAKING (B.O.F.)
PLANT: R
PRODUCTION: 7760 METRIC TONS STEEL/DAY (8556 TONS STEEL/DAY)
SECONDARY SPRAYS WATER
HOOD WATER COOLING TOWER
HOOD & DAMPER COOLING WATER
TO SPARK BOXES
TO SPARK BOXES
PRIMARY SPRAYS WATER
CASCADE SPRAYS WATER
FCE. HOOD
2 FCE. STACK
FCE. HOOD
3 FCE. STACK
LANCE COOLING WATER SUPPLY
LANCE COOLING WATER RETURN
CLARIFIER UNDERFLOW (NOT RUNNING DURING SAMPLING PERIOD)
POLYMER FEED
48.6 l/SEC (770 GPM AVG)
MAKE-UP 1.3 l/SEC. (20 GPM)
SETTLING TANKS (2)
LADLE
49.8 l/SEC (790 GPM AVG.)
SPRAY WATER PUMPS
1
2
3
4
5
SAMPLING POINT
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
RD 4/28/78
FIGURE VII-1


PROCESS: STEELMAKING (BOF)
PLANT: U
PRODUCTION: 2691 METRIC TONS STEEL PER DAY (2967 TONS STEEL PER DAY)
DIRTY GAS
SCRUBBED GAS
SERVICE WATER INLET
4
TOWER COOLER
ELECTROSTATIC PRECIPITATOR
EXHAUST STACK
B.O.F.
INDUCED DRAFT FAN
126.2 ℓ/SEC. (2000 GPM) NON-CONTACT COOLING DIRECT TO RIVER
CONTACT WATER OUT 94.6 ℓ/SEC. (1500 GPM)
1
POLYELECTROLYTE ADDITION
THICKENER OVERFLOW DIRECT TO RIVER 94.6 ℓ/SEC. (1500 GPM)
25.6m (84 FT.) DIAMETER THICKENER
APPROX. 10 HRS. DETENTION
OVERFLOW RATE 11 ℓ/m² / MIN.
(0.27 GAL./FT.² / MIN.)
2
RIVER OUTFALL 220.8 ℓ/SEC. (3500 GPM)
3
VACUUM FILTERS
FILTRATE APPROX. 3.2 ℓ/SEC. (50 GPM) ESTIMATED
SLUDGE
△-SAMPLING POINTS
RD4/26/78

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-2



MISC. COOLING WATER
12 l/SEC (192 GPM)
DISTRIBUTION BOX
251 l/SEC (3978 GPM)
263.1 l/SEC (4170 GPM)
THICKENERS-2
284.6 l/SEC (4510 GPM)
CLASSIFIER
22 l/SEC (350 GPM)
273 l/SEC (4328 GPM)
FILTRATE & WASHINGS
4.4 l/SEC (70 GPM)
MAKE-UP WATER
11.5 l/SEC (183 GPM)
TO SEWER
14.5 l/SEC (230 GPM)
270 l/SEC (4280 GPM)
FROM RIVER WATER INTAKE
281.6 l/SEC (4463 GPM)
EVAPORATION
4 l/SEC (65 GPM)
GAS CLEANING SYSTEM
VACUUM FILTERS
FILTER WASHING AND VACUUM PUMPS
FILTER CAKE
WITH 0.63 l/SEC
(10 GPM) MOISTURE
△ SAMPLING POINT

PROCESS: STEELMAKING (BOF)

PLANT: S

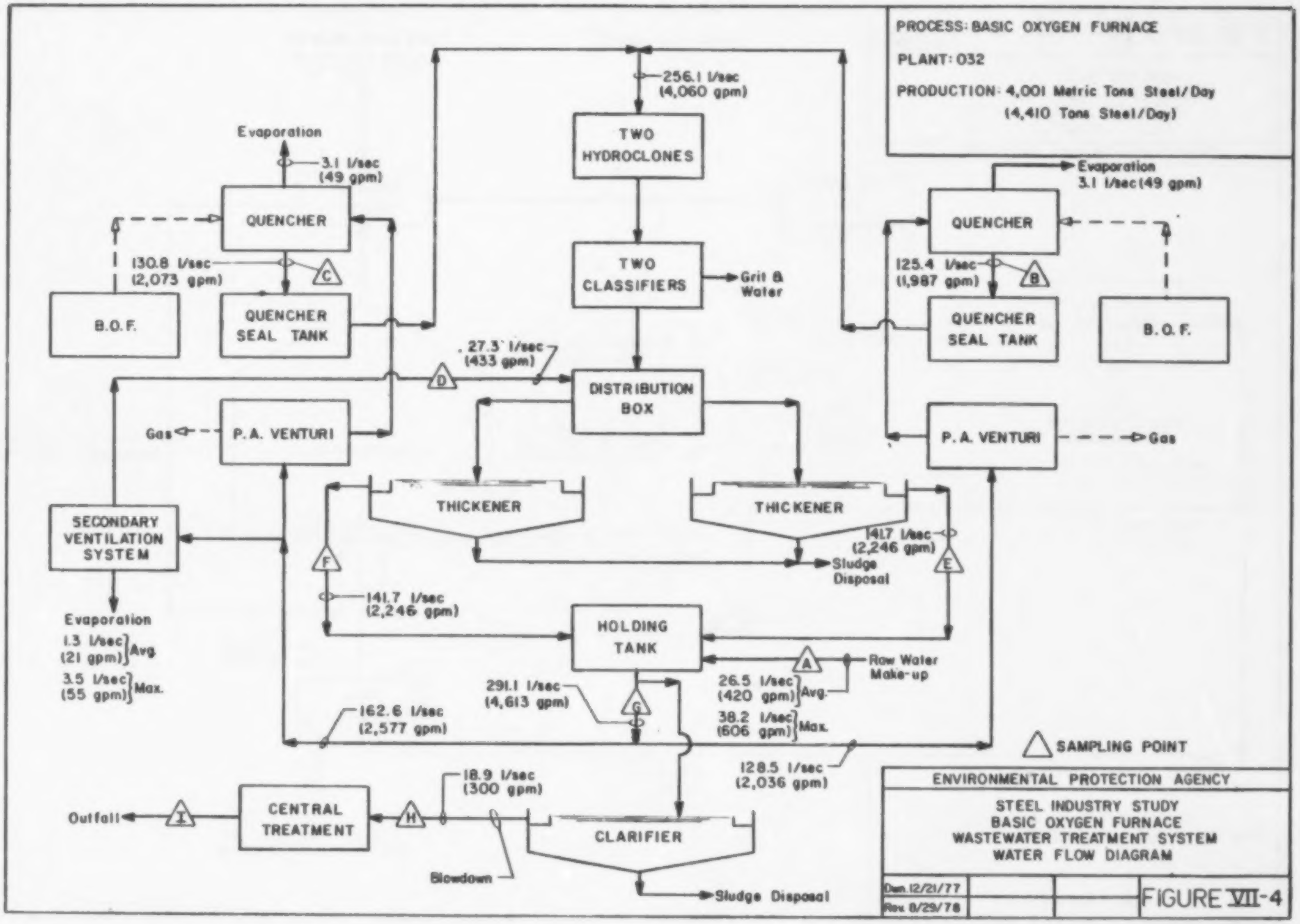
PRODUCTION: 5755.8 METRIC TONS STEEL/DAY
(6346 TONS STEEL/DAY)

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

RD 4/25/78

FIGURE VII-3

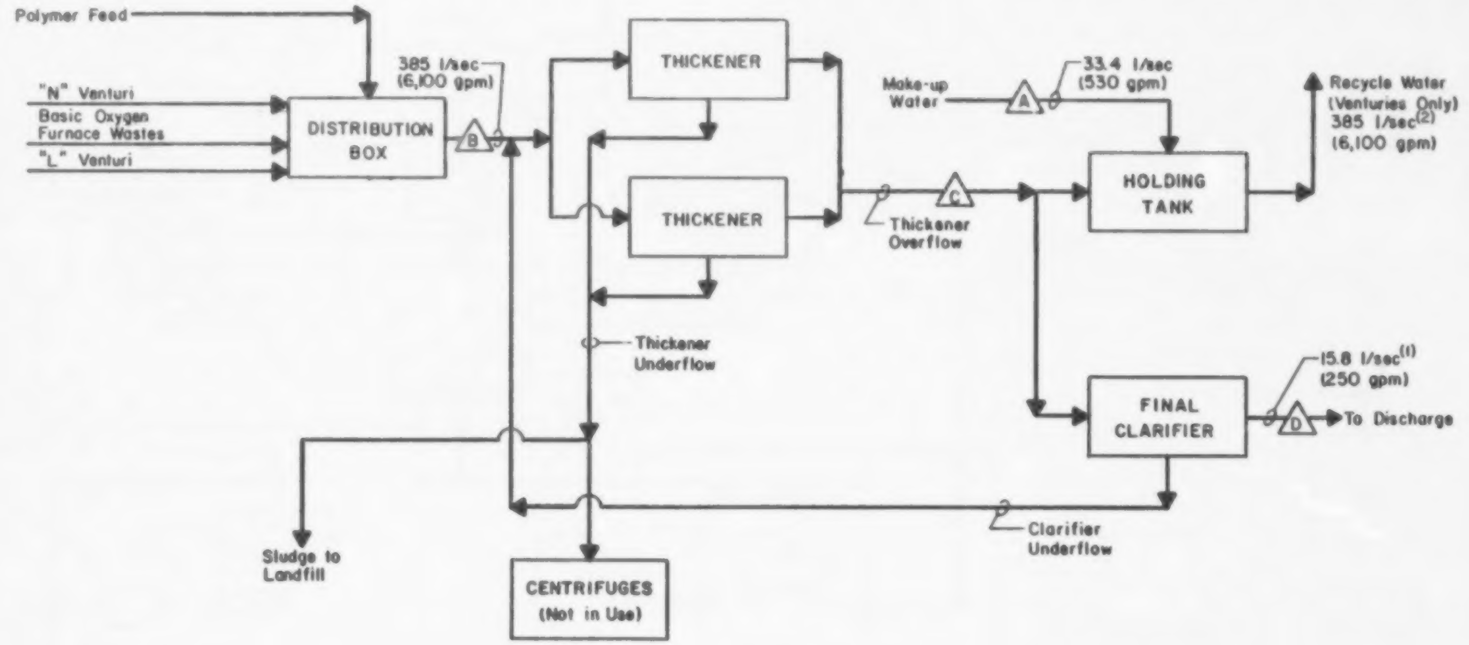

PROCESS: BASIC OXYGEN FURNACE
PLANT: 032
PRODUCTION: 4,001 Metric Tons Steel/Day
(4,410 Tons Steel/Day)
256.1 l/sec
(4,060 gpm)
TWO HYDROCLONES
TWO CLASSIFIERS
Grit & Water
DISTRIBUTION BOX
Evaporation
3.1 l/sec
(49 gpm)
QUENCHER
130.8 l/sec
(2,073 gpm)
C
B.O.F.
QUENCHER SEAL TANK
Evaporation
3.1 l/sec (49 gpm)
QUENCHER
125.4 l/sec
(1,987 gpm)
B
QUENCHER SEAL TANK
B.O.F.
27.3 l/sec
(433 gpm)
D
Gas
P. A. VENTURI
P. A. VENTURI
Gas
THICKENER
THICKENER
SECONDARY VENTILATION SYSTEM
F
141.7 l/sec
(2,246 gpm)
141.7 l/sec
(2,246 gpm)
E
Sludge Disposal
Evaporation
1.3 l/sec
(21 gpm) Avg.
3.5 l/sec
(55 gpm) Max.
HOLDING TANK
A
Raw Water Make-up
26.5 l/sec
(420 gpm) Avg.
38.2 l/sec
(606 gpm) Max.
291.1 l/sec
(4,613 gpm)
G
162.6 l/sec
(2,577 gpm)
128.5 l/sec
(2,036 gpm)
SAMPLING POINT
18.9 l/sec
(300 gpm)
Outfall
I
CENTRAL TREATMENT
H
CLARIFIER
Blowdown
Sludge Disposal
Dwn. 12/21/77
Rev. 8/29/78

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VIII-4

PROCESS: BASIC OXYGEN FURNACE - WET
PLANT: 034
PRODUCTION: 6,953 Metric Tons Steel/Day
(7,666 Tons Steel/Day)


Polymer Feed
"N" Venturi
Basic Oxygen Furnace Wastes
"L" Venturi
DISTRIBUTION BOX
385 l/sec (6,100 gpm)
B
THICKENER
THICKENER
Thickener Underflow
Make-up Water
A
33.4 l/sec (530 gpm)
C
Thickener Overflow
HOLDING TANK
Recycle Water (Venturies Only) 385 l/sec(2) (6,100 gpm)
FINAL CLARIFIER
15.8 l/sec(1) (250 gpm)
D
To Discharge
Clarifier Underflow
Sludge to Landfill
CENTRIFUGES (Not in Use)

△ SAMPLING POINT

NOTES:
(1) Measured flow value.
(2) Flow based upon recycle pump data.

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

DWN. 6-20-77

FIGURE VII-5

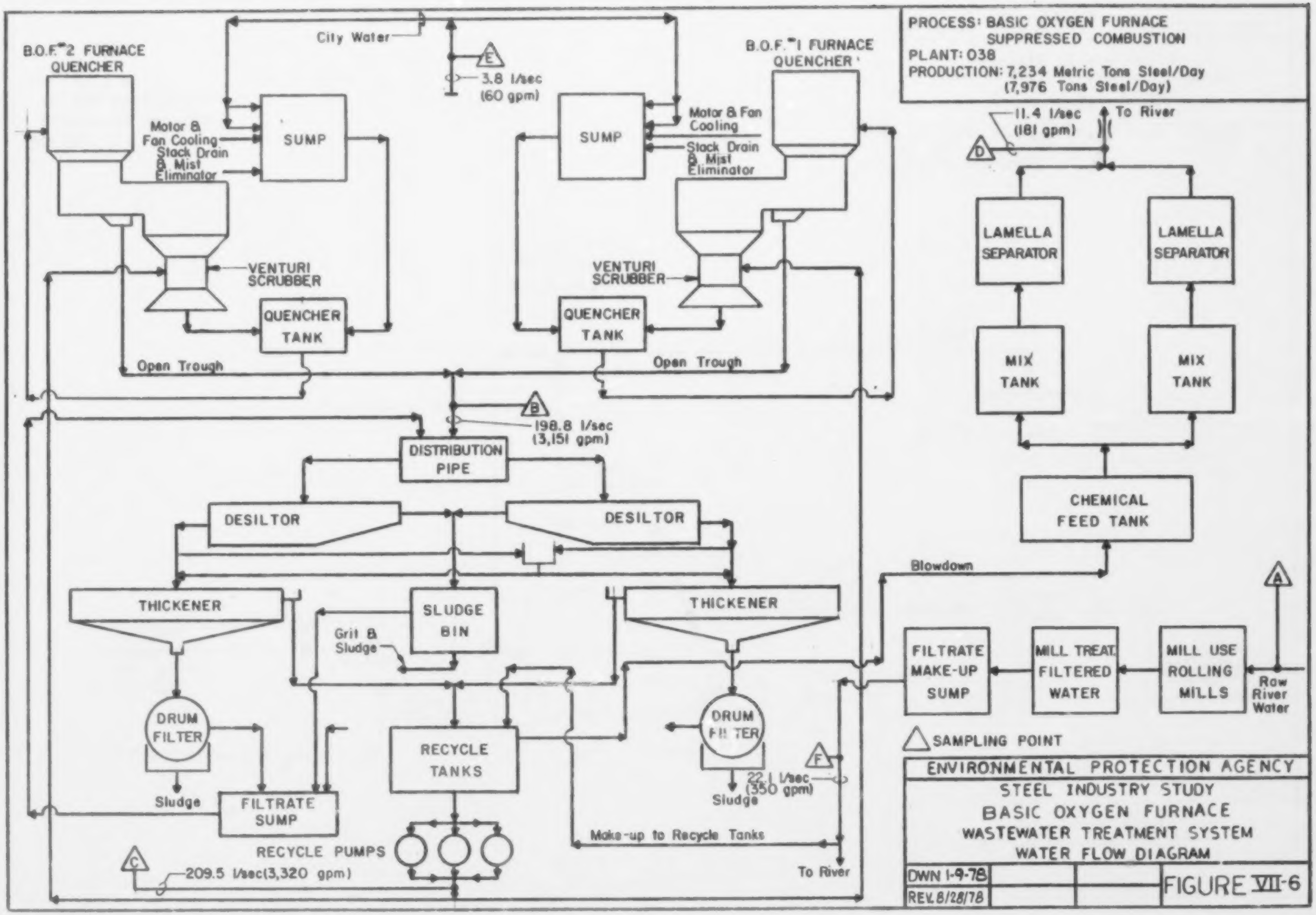
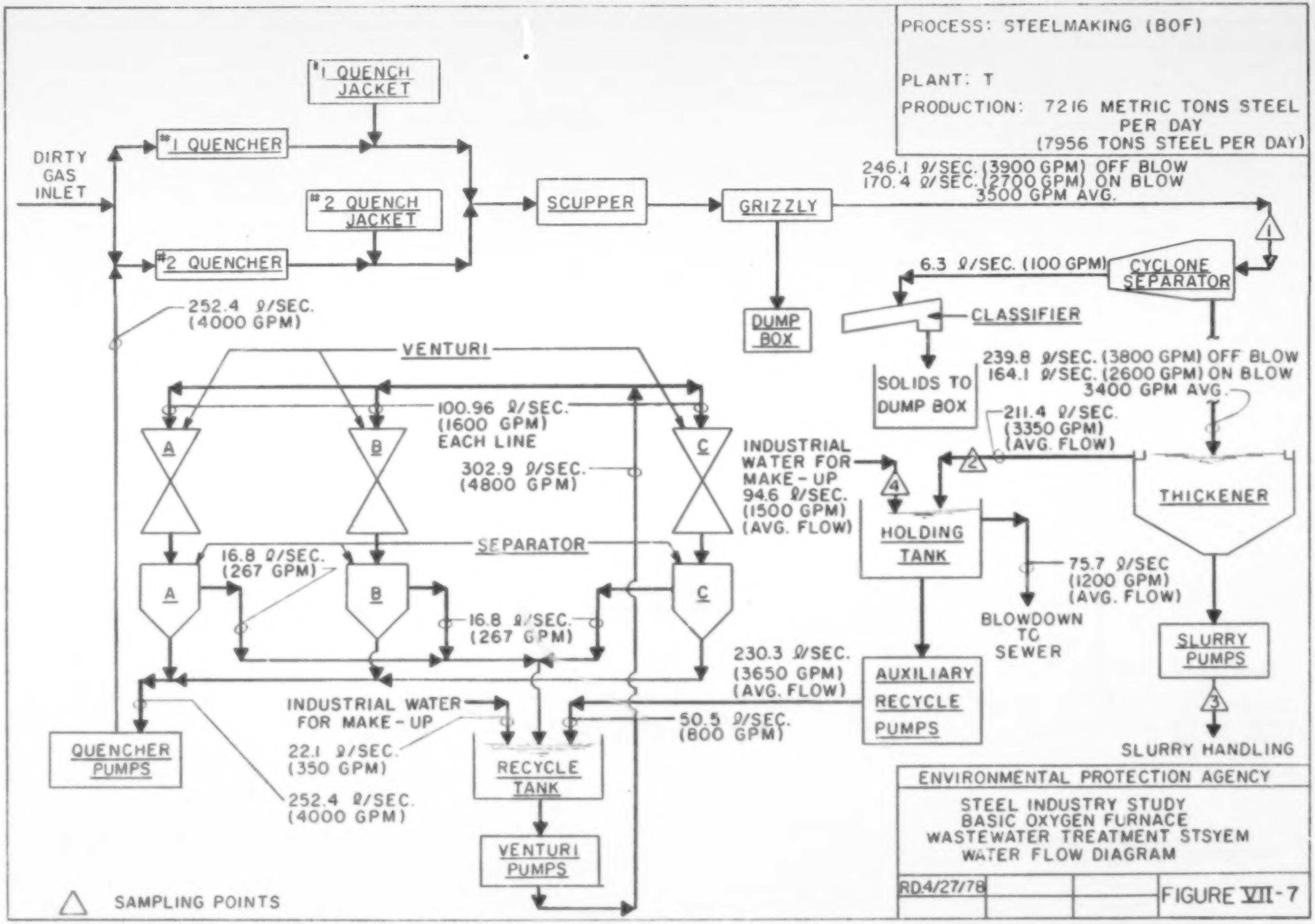

PROCESS: BASIC OXYGEN FURNACE
SUPPRESSED COMBUSTION
PLANT: 038
PRODUCTION: 7,234 Metric Tons Steel/Day
(7,976 Tons Steel/Day)
B.O.F. #2 FURNACE QUENCHER
B.O.F. #1 FURNACE QUENCHER
City Water
E
3.8 l/sec
(60 gpm)
Motor & Fan Cooling
Stack Drain & Mist Eliminator
SUMP
VENTURI SCRUBBER
QUENCHER TANK
Open Trough
B
198.8 l/sec
(3,151 gpm)
DISTRIBUTION PIPE
DESILTOR
THICKENER
SLUDGE BIN
Grit & Sludge
DRUM FILTER
Sludge
FILTRATE SUMP
RECYCLE TANKS
RECYCLE PUMPS
C
209.5 l/sec(3,320 gpm)
Make-up to Recycle Tanks
To River
F
22.1 l/sec
(350 gpm)
D
11.4 l/sec
(181 gpm)
To River
LAMELLA SEPARATOR
MIX TANK
CHEMICAL FEED TANK
Blowdown
A
FILTRATE MAKE-UP SUMP
MILL TREAT. FILTERED WATER
MILL USE ROLLING MILLS
Raw River Water
SAMPLING POINT
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
DWN 1-9-78
REV. 8/28/78

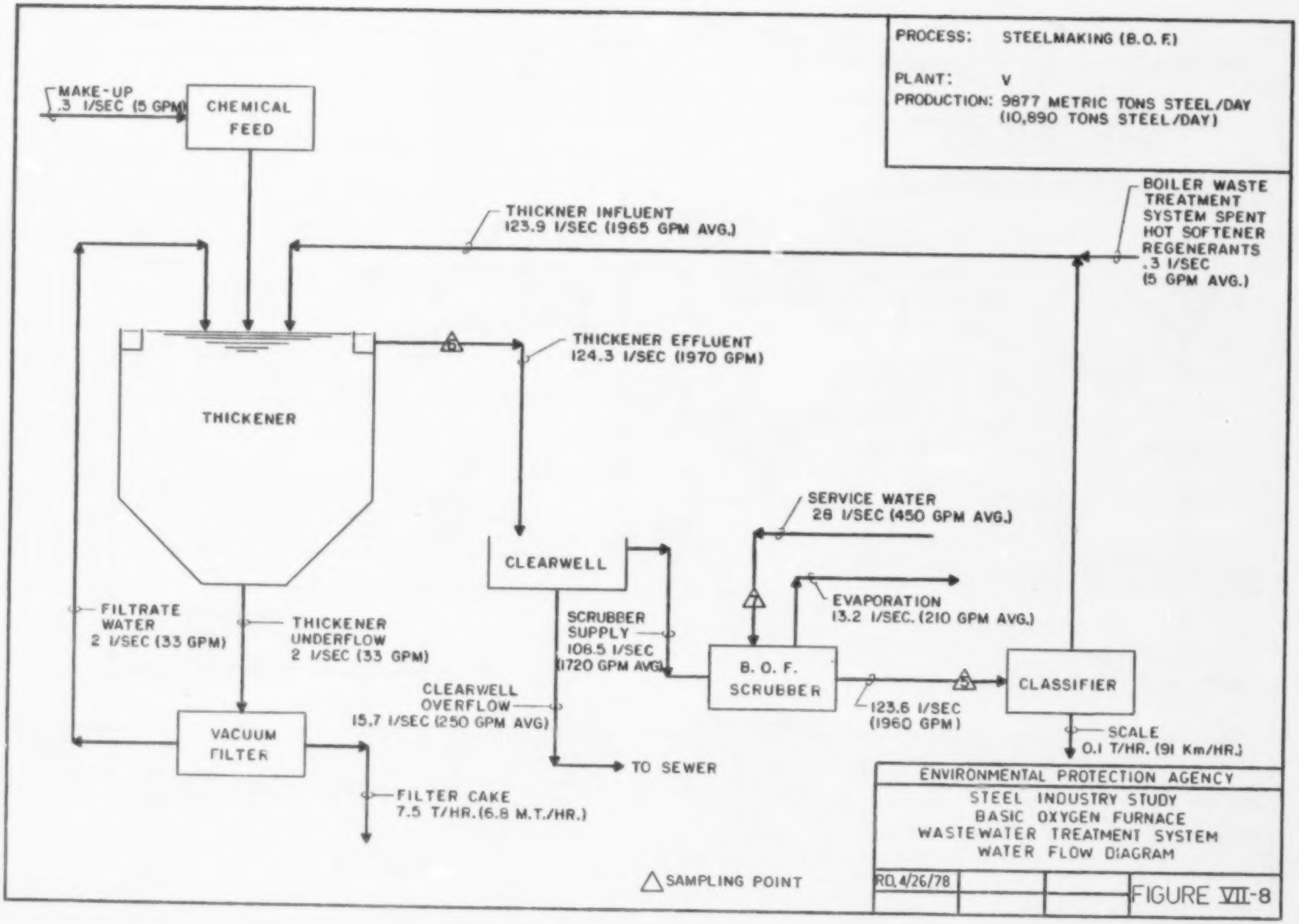
FIGURE VII-6


PROCESS: STEELMAKING (BOF)
PLANT: T
PRODUCTION: 7216 METRIC TONS STEEL PER DAY
(7956 TONS STEEL PER DAY)
DIRTY GAS INLET
#1 QUENCH JACKET
#1 QUENCHER
#2 QUENCH JACKET
#2 QUENCHER
SCUPPER
GRIZZLY
DUMP BOX
246.1 ℓ/SEC. (3900 GPM) OFF BLOW
170.4 ℓ/SEC. (2700 GPM) ON BLOW
3500 GPM AVG.
1
CYCLONE SEPARATOR
6.3 ℓ/SEC. (100 GPM)
CLASSIFIER
SOLIDS TO DUMP BOX
239.8 ℓ/SEC. (3800 GPM) OFF BLOW
164.1 ℓ/SEC. (2600 GPM) ON BLOW
3400 GPM AVG.
211.4 ℓ/SEC. (3350 GPM) (AVG. FLOW)
2
THICKENER
SLURRY PUMPS
3
SLURRY HANDLING
INDUSTRIAL WATER FOR MAKE-UP 94.6 ℓ/SEC. (1500 GPM) (AVG. FLOW)
4
HOLDING TANK
75.7 ℓ/SEC (1200 GPM) (AVG. FLOW)
BLOWDOWN TO SEWER
AUXILIARY RECYCLE PUMPS
230.3 ℓ/SEC. (3650 GPM) (AVG. FLOW)
252.4 ℓ/SEC. (4000 GPM)
VENTURI
100.96 ℓ/SEC. (1600 GPM) EACH LINE
302.9 ℓ/SEC. (4800 GPM)
A
B
C
SEPARATOR
16.8 ℓ/SEC. (267 GPM)
16.8 ℓ/SEC. (267 GPM)
INDUSTRIAL WATER FOR MAKE-UP
22.1 ℓ/SEC. (350 GPM)
50.5 ℓ/SEC. (800 GPM)
RECYCLE TANK
VENTURI PUMPS
QUENCHER PUMPS
252.4 ℓ/SEC. (4000 GPM)
△ SAMPLING POINTS
RD.4/27/78

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT STSYEM
WATER FLOW DIAGRAM

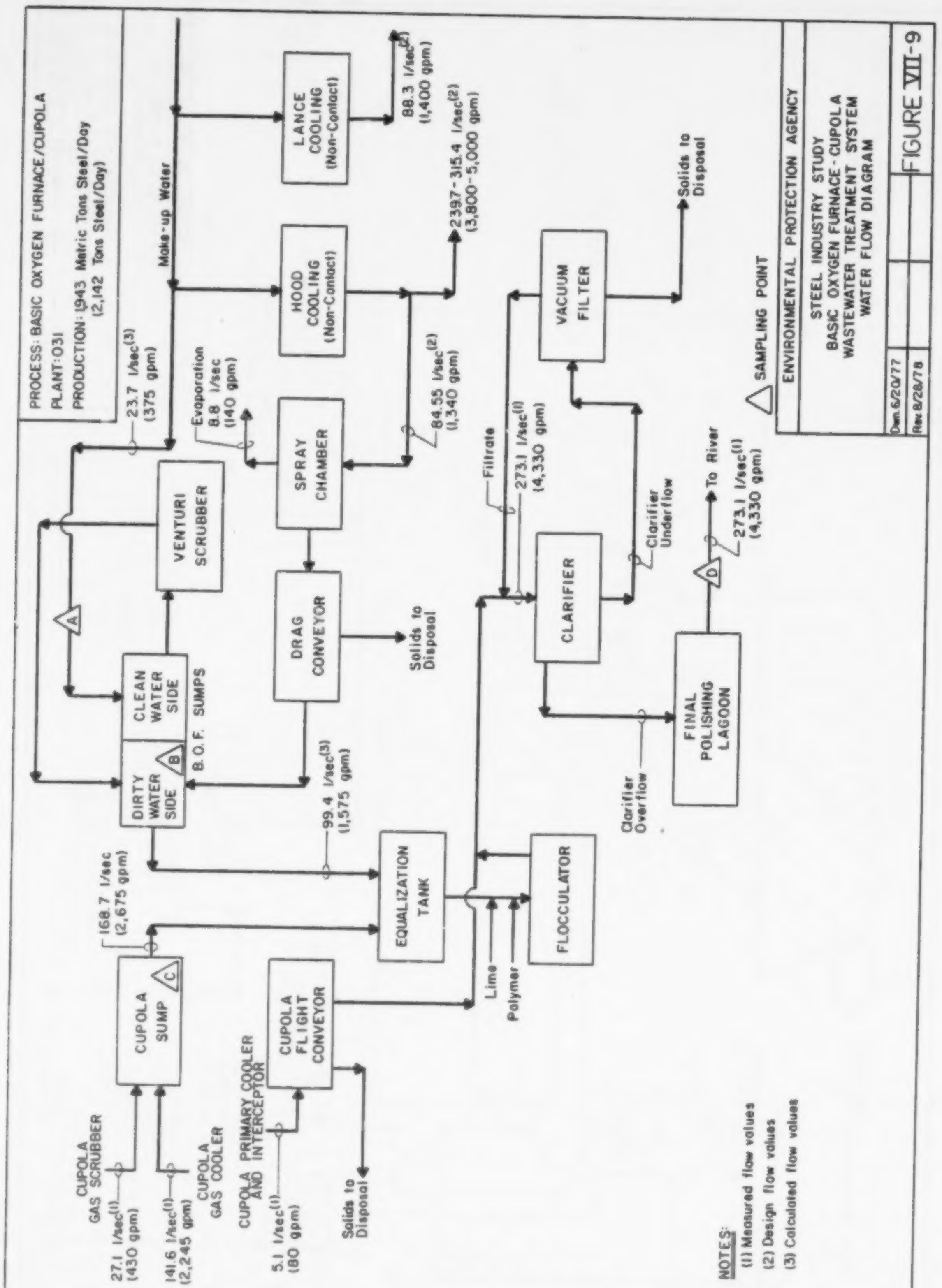
FIGURE VII-7


PROCESS: STEELMAKING (B.O.F.)
PLANT: V
PRODUCTION: 9877 METRIC TONS STEEL/DAY (10,890 TONS STEEL/DAY)
MAKE-UP .3 l/SEC (5 GPM)
CHEMICAL FEED
THICKNER INFLUENT 123.9 l/SEC (1965 GPM AVG.)
BOILER WASTE TREATMENT SYSTEM SPENT HOT SOFTENER REGENERANTS .3 l/SEC (5 GPM AVG.)
THICKENER
6
THICKENER EFFLUENT 124.3 l/SEC (1970 GPM)
SERVICE WATER 28 l/SEC (450 GPM AVG.)
7
CLEARWELL
EVAPORATION 13.2 l/SEC. (210 GPM AVG.)
FILTRATE WATER 2 l/SEC (33 GPM)
THICKENER UNDERFLOW 2 l/SEC (33 GPM)
SCRUBBER SUPPLY 108.5 l/SEC (1720 GPM AVG)
B. O. F. SCRUBBER
5
CLASSIFIER
CLEARWELL OVERFLOW 15.7 l/SEC (250 GPM AVG)
123.6 l/SEC (1960 GPM)
SCALE 0.1 T/HR. (91 Km/HR.)
VACUUM FILTER
TO SEWER
FILTER CAKE 7.5 T/HR. (6.8 M.T./HR.)
△ SAMPLING POINT
RD, 4/26/78

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-8

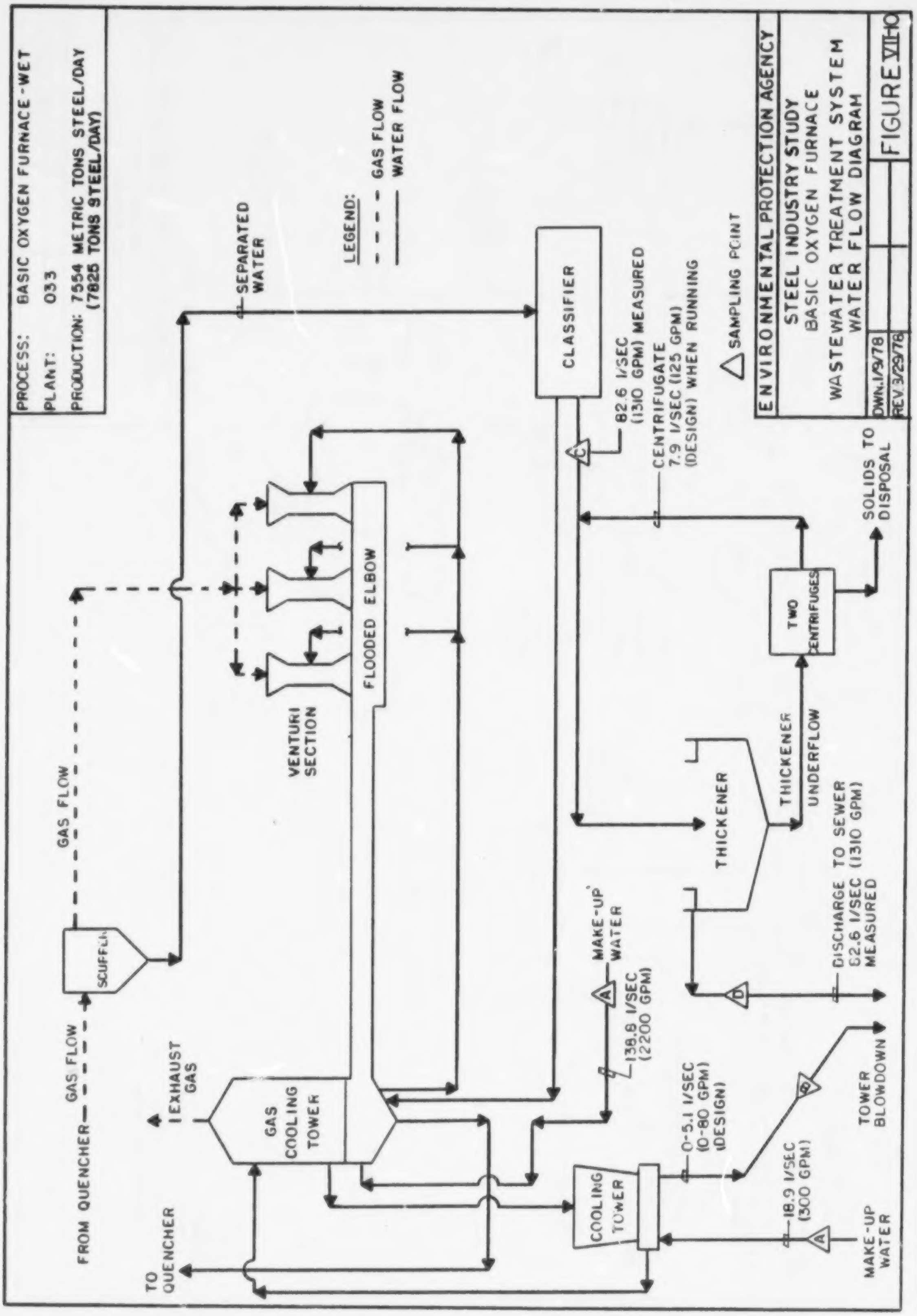

PROCESS: BASIC OXYGEN FURNACE/CUPOLA
PLANT: 031
PRODUCTION: 1943 Metric Tons Steel/Day
(2,142 Tons Steel/Day)
Make-up Water
LANCE COOLING (Non-Contact)
88.3 l/sec(2) (1,400 gpm)
HOOD COOLING (Non-Contact)
2397-315.4 l/sec(2) (3,800-5,000 gpm)
23.7 l/sec(3) (375 gpm)
Evaporation 8.8 l/sec (140 gpm)
SPRAY CHAMBER
84.55 l/sec(2) (1,340 gpm)
VENTURI SCRUBBER
A
CLEAN WATER SIDE
DIRTY WATER SIDE
B
B.O.F. SUMPS
DRAG CONVEYOR
Solids to Disposal
99.4 l/sec(3) (1,575 gpm)
VACUUM FILTER
Solids to Disposal
Filtrate
273.1 l/sec(1) (4,330 gpm)
CLARIFIER
Clarifier Underflow
To River
273.1 l/sec(1) (4,330 gpm)
D
FINAL POLISHING LAGOON
Clarifier Overflow
EQUALIZATION TANK
FLOCCULATOR
Lime
Polymer
168.7 l/sec (2,675 gpm)
CUPOLA SUMP
C
CUPOLA FLIGHT CONVEYOR
CUPOLA GAS SCRUBBER
27.1 l/sec(1) (430 gpm)
CUPOLA GAS COOLER
141.6 l/sec(1) (2,245 gpm)
CUPOLA PRIMARY COOLER AND INTERCEPTOR
5.1 l/sec(1) (80 gpm)
Solids to Disposal
SAMPLING POINT

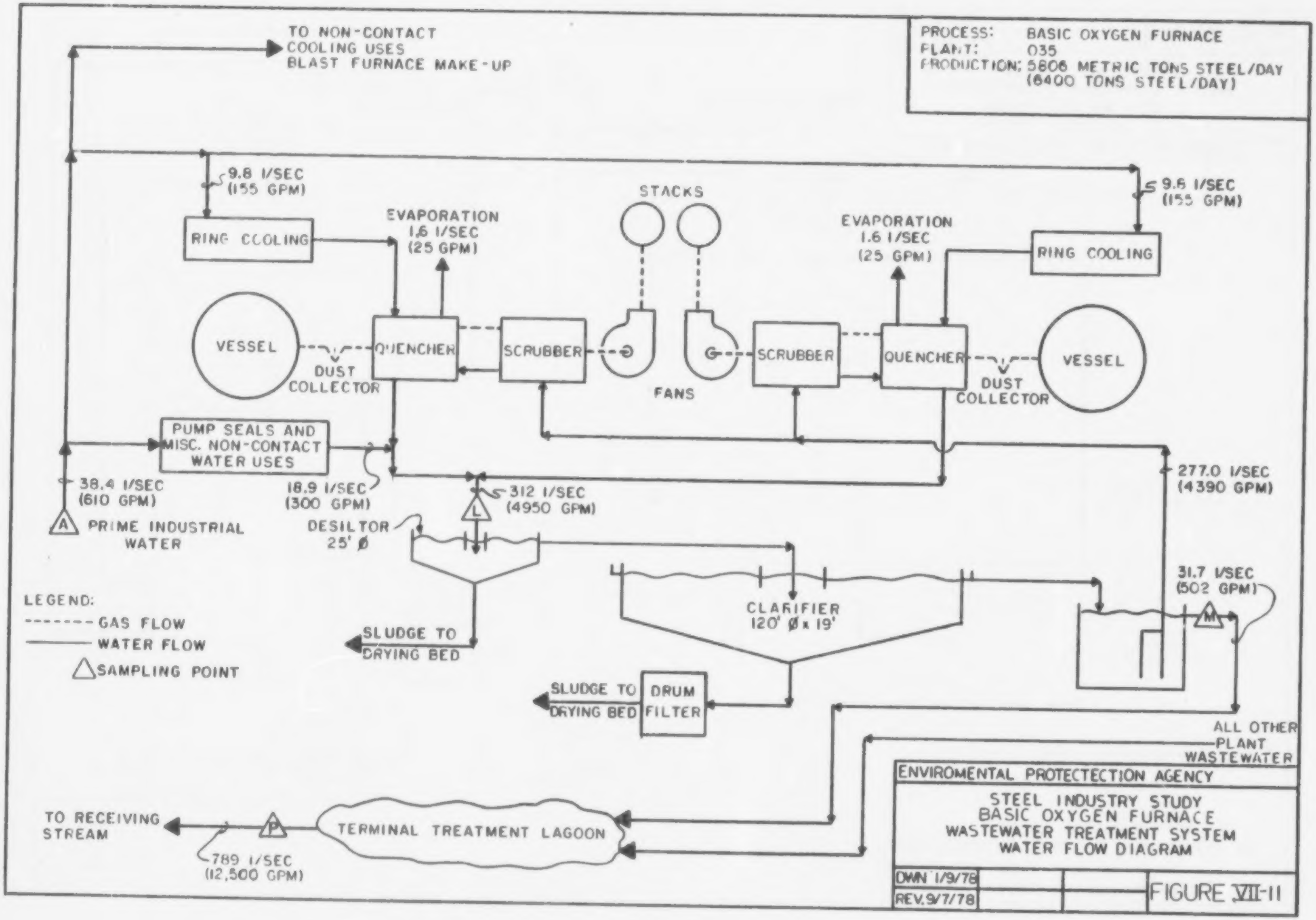
NOTES:
(1) Measured flow values
(2) Design flow values
(3) Calculated flow values

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE-CUPOLA
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

Dwn. 6/20/77
Rev. 8/28/78

FIGURE VII-9

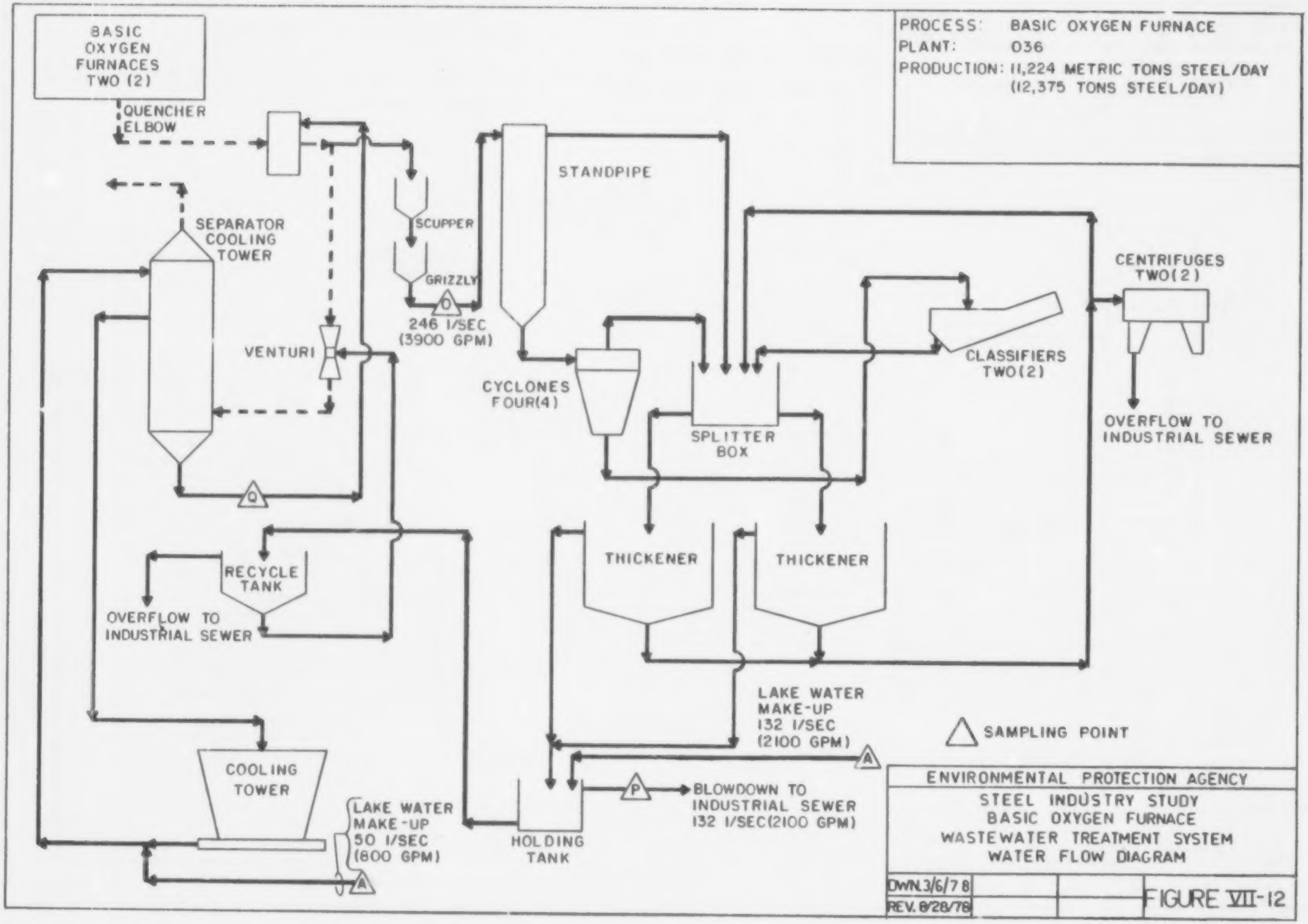

PROCESS: BASIC OXYGEN FURNACE-WET
PLANT: 033
PRODUCTION: 7554 METRIC TONS STEEL/DAY (7825 TONS STEEL/DAY)
LEGEND:
- - - GAS FLOW
—— WATER FLOW
GAS FLOW
FROM QUENCHER
GAS FLOW
SCUFFLE
SEPARATED WATER
VENTURI SECTION
FLOODED ELBOW
CLASSIFIER
82.6 l/SEC (1310 GPM) MEASURED
C
CENTRIFUGATE 7.9 l/SEC (125 GPM) (DESIGN) WHEN RUNNING
SAMPLING POINT
TWO CENTRIFUGES
SOLIDS TO DISPOSAL
THICKENER
THICKENER UNDERFLOW
DISCHARGE TO SEWER 82.6 l/SEC (1310 GPM) MEASURED
D
MAKE-UP WATER
A
138.8 l/SEC (2200 GPM)
EXHAUST GAS
GAS COOLING TOWER
COOLING TOWER
0-5.1 l/SEC (0-80 GPM) (DESIGN)
B
TOWER BLOWDOWN
18.9 l/SEC (300 GPM)
A
MAKE-UP WATER
TO QUENCHER
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
DWN. 1/9/78
REV. 3/29/78
FIGURE VII-10


PROCESS: BASIC OXYGEN FURNACE
PLANT: 035
PRODUCTION: 5806 METRIC TONS STEEL/DAY
(6400 TONS STEEL/DAY)
TO NON-CONTACT
COOLING USES
BLAST FURNACE MAKE-UP
9.8 l/SEC
(155 GPM)
9.6 l/SEC
(155 GPM)
RING COOLING
RING COOLING
EVAPORATION
1.6 l/SEC
(25 GPM)
EVAPORATION
1.6 l/SEC
(25 GPM)
STACKS
VESSEL
VESSEL
QUENCHER
QUENCHER
SCRUBBER
SCRUBBER
DUST
COLLECTOR
DUST
COLLECTOR
FANS
PUMP SEALS AND
MISC. NON-CONTACT
WATER USES
38.4 l/SEC
(610 GPM)
18.9 l/SEC
(300 GPM)
312 l/SEC
(4950 GPM)
277.0 l/SEC
(4390 GPM)
A
PRIME INDUSTRIAL
WATER
L
DESILTOR
25' Ø
SLUDGE TO
DRYING BED
CLARIFIER
120' Ø x 19'
31.7 l/SEC
(502 GPM)
M
SLUDGE TO
DRYING BED
DRUM
FILTER
ALL OTHER
PLANT
WASTEWATER
TO RECEIVING
STREAM
P
789 l/SEC
(12,500 GPM)
TERMINAL TREATMENT LAGOON
LEGEND:
------- GAS FLOW
——— WATER FLOW
△ SAMPLING POINT
DWN 1/9/78
REV. 9/7/78

ENVIROMENTAL PROTECTECTION AGENCY

STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-11

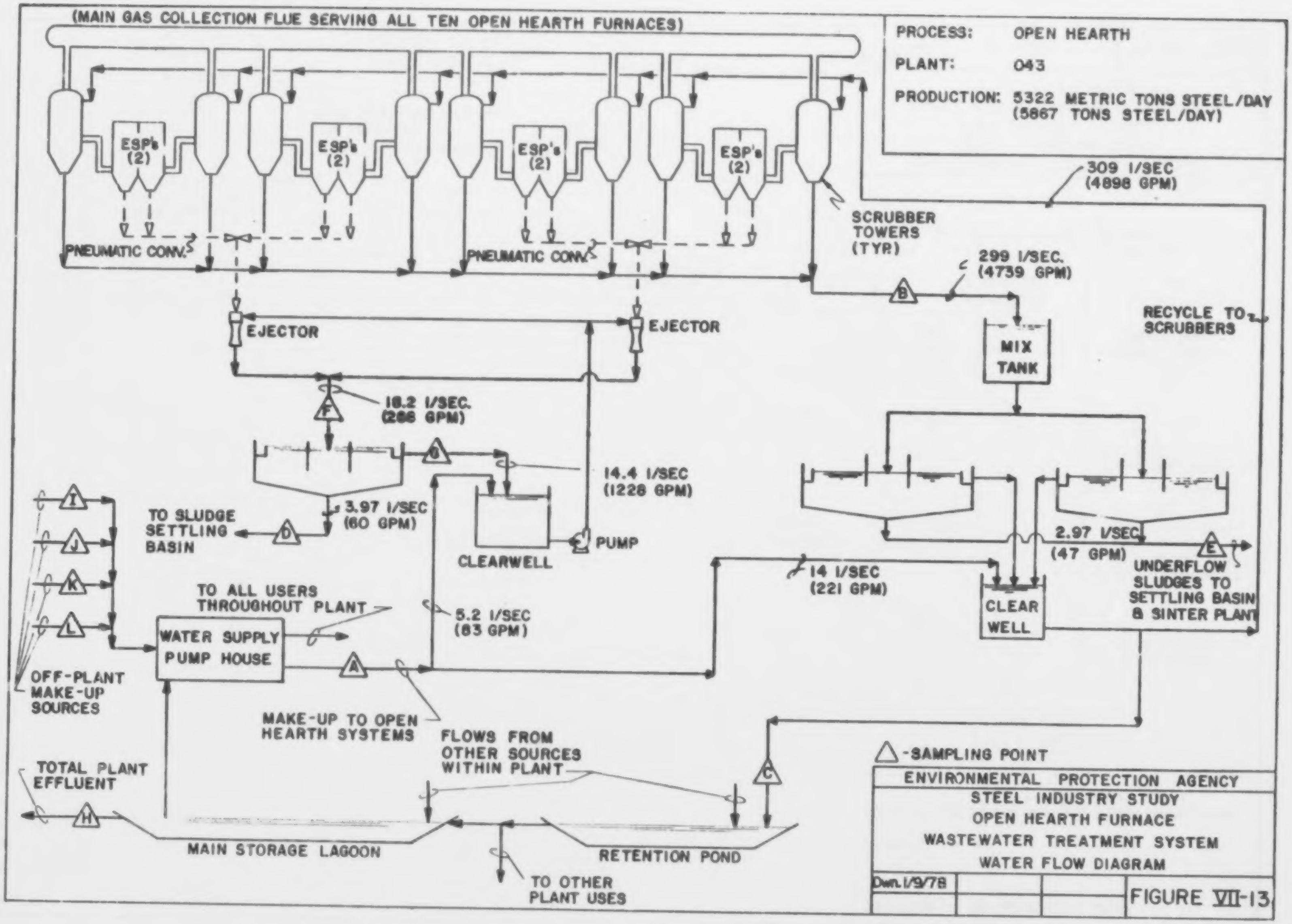

BASIC OXYGEN FURNACES TWO (2)
QUENCHER ELBOW
SEPARATOR COOLING TOWER
VENTURI
Q
SCUPPER
GRIZZLY
O
246 l/SEC (3900 GPM)
STANDPIPE
CYCLONES FOUR(4)
SPLITTER BOX
CLASSIFIERS TWO(2)
CENTRIFUGES TWO(2)
OVERFLOW TO INDUSTRIAL SEWER
THICKENER
THICKENER
RECYCLE TANK
OVERFLOW TO INDUSTRIAL SEWER
COOLING TOWER
LAKE WATER MAKE-UP 50 l/SEC (800 GPM)
A
HOLDING TANK
P
BLOWDOWN TO INDUSTRIAL SEWER 132 l/SEC(2100 GPM)
LAKE WATER MAKE-UP 132 l/SEC (2100 GPM)
A
SAMPLING POINT

PROCESS: BASIC OXYGEN FURNACE
PLANT: 036
PRODUCTION: 11,224 METRIC TONS STEEL/DAY
(12,375 TONS STEEL/DAY)

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
BASIC OXYGEN FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

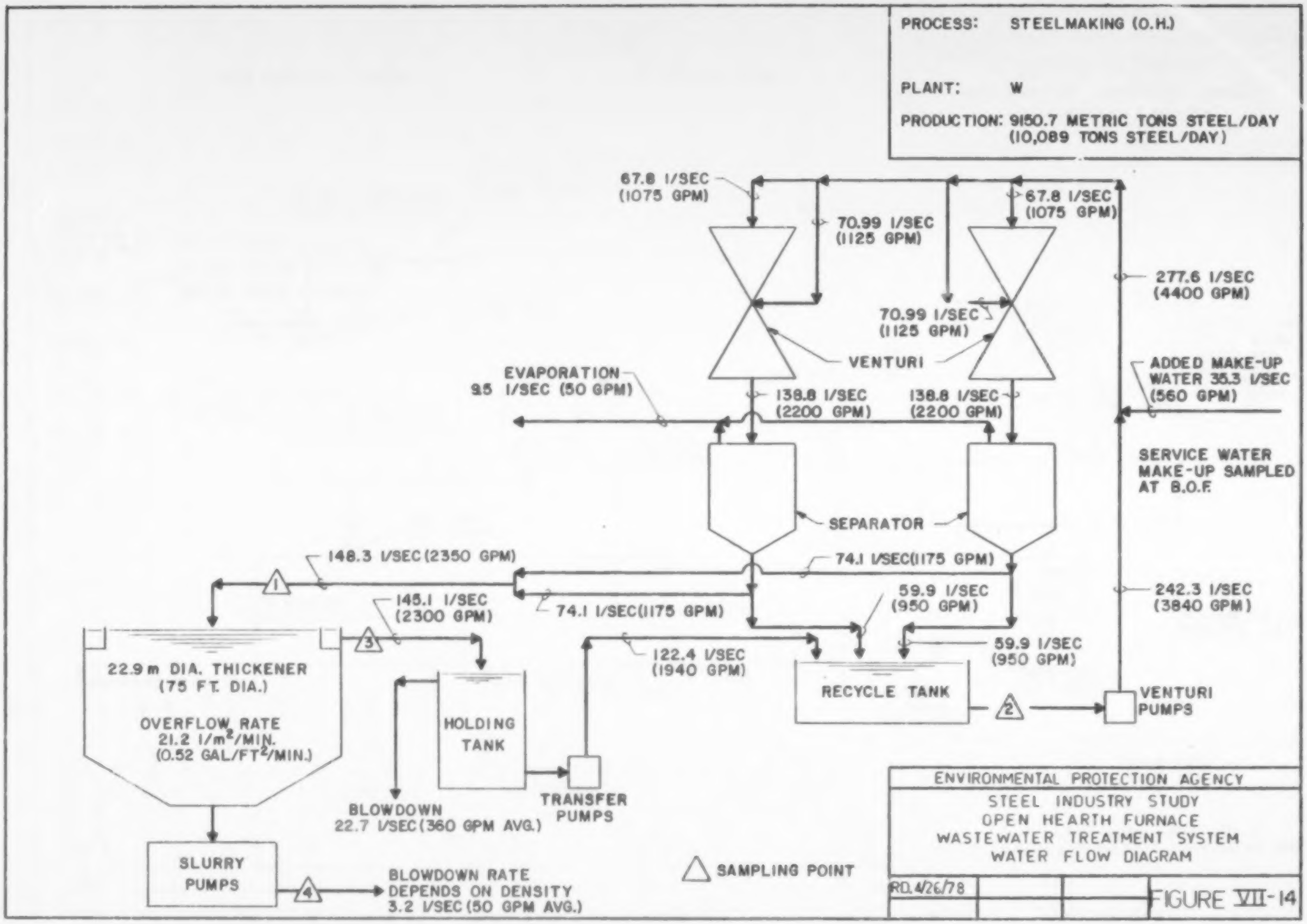
DWN. 3/6/78
REV. 8/28/78

FIGURE VII-12


(MAIN GAS COLLECTION FLUE SERVING ALL TEN OPEN HEARTH FURNACES)
PROCESS: OPEN HEARTH
PLANT: 043
PRODUCTION: 5322 METRIC TONS STEEL/DAY (5867 TONS STEEL/DAY)
ESP's (2)
ESP's (2)
ESP's (2)
ESP's (2)
309 l/SEC (4898 GPM)
SCRUBBER TOWERS (TYP.)
PNEUMATIC CONV.
PNEUMATIC CONV.
299 l/SEC. (4739 GPM)
B
EJECTOR
EJECTOR
RECYCLE TO SCRUBBERS
MIX TANK
F
18.2 l/SEC. (288 GPM)
G
14.4 l/SEC (1228 GPM)
I
J
K
L
TO SLUDGE SETTLING BASIN
D
3.97 l/SEC (60 GPM)
CLEARWELL
PUMP
2.97 l/SEC (47 GPM)
E
14 l/SEC (221 GPM)
CLEAR WELL
UNDERFLOW SLUDGES TO SETTLING BASIN & SINTER PLANT
TO ALL USERS THROUGHOUT PLANT
5.2 l/SEC (83 GPM)
WATER SUPPLY PUMP HOUSE
A
OFF-PLANT MAKE-UP SOURCES
MAKE-UP TO OPEN HEARTH SYSTEMS
FLOWS FROM OTHER SOURCES WITHIN PLANT
C
TOTAL PLANT EFFLUENT
H
MAIN STORAGE LAGOON
RETENTION POND
TO OTHER PLANT USES
△ -SAMPLING POINT
Dwn.1/9/78

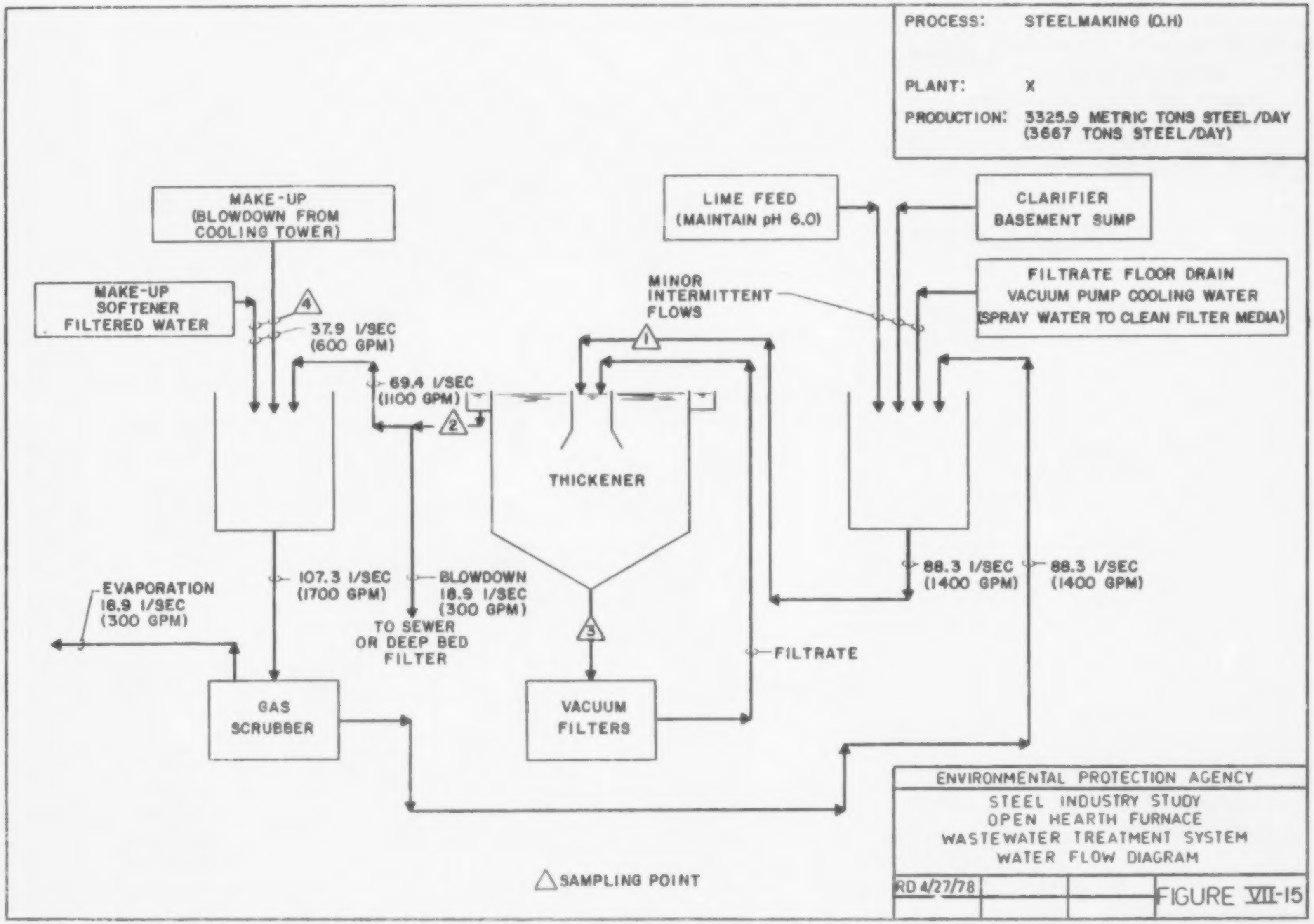
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
OPEN HEARTH FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-13


PROCESS: STEELMAKING (O.H.)
PLANT: W
PRODUCTION: 9150.7 METRIC TONS STEEL/DAY (10,089 TONS STEEL/DAY)
67.8 l/SEC (1075 GPM)
70.99 l/SEC (1125 GPM)
67.8 l/SEC (1075 GPM)
277.6 l/SEC (4400 GPM)
70.99 l/SEC (1125 GPM)
VENTURI
ADDED MAKE-UP WATER 35.3 l/SEC (560 GPM)
EVAPORATION 9.5 l/SEC (50 GPM)
138.8 l/SEC (2200 GPM)
138.8 l/SEC (2200 GPM)
SERVICE WATER MAKE-UP SAMPLED AT B.O.F.
SEPARATOR
148.3 l/SEC (2350 GPM)
74.1 l/SEC (1175 GPM)
59.9 l/SEC (950 GPM)
242.3 l/SEC (3840 GPM)
145.1 l/SEC (2300 GPM)
74.1 l/SEC (1175 GPM)
122.4 l/SEC (1940 GPM)
59.9 l/SEC (950 GPM)
1
2
3
4
22.9 m DIA. THICKENER (75 FT. DIA.)
OVERFLOW RATE 21.2 l/m²/MIN. (0.52 GAL/FT²/MIN.)
HOLDING TANK
RECYCLE TANK
VENTURI PUMPS
TRANSFER PUMPS
BLOWDOWN 22.7 l/SEC (360 GPM AVG.)
SLURRY PUMPS
BLOWDOWN RATE DEPENDS ON DENSITY 3.2 l/SEC (50 GPM AVG.)
SAMPLING POINT
RD. 4/26/78

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
OPEN HEARTH FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VIII-14



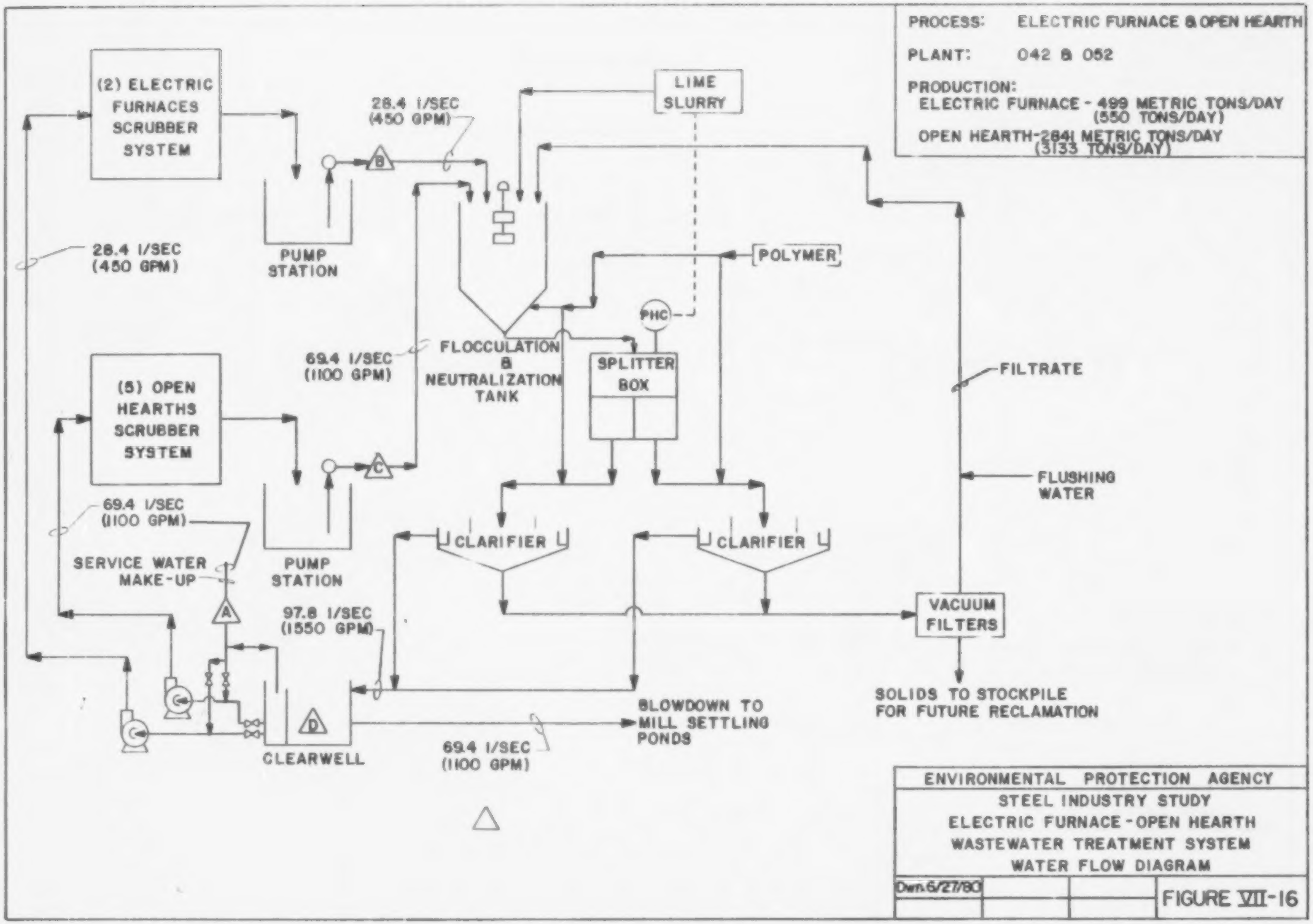
ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
OPEN HEARTH FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

RD 4/27/78

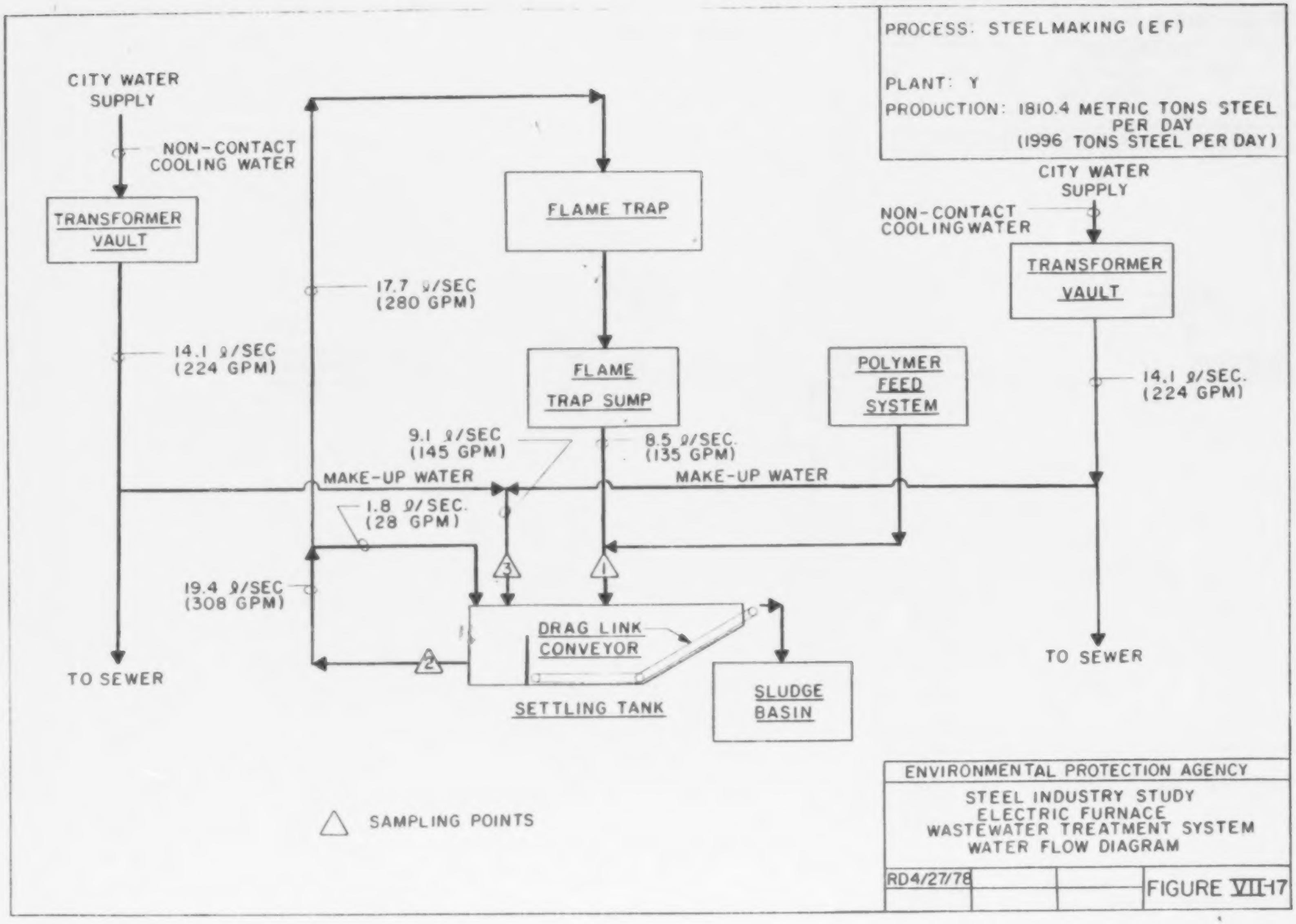
FIGURE VII-15

PROCESS: STEELMAKING (O.H)
PLANT: X
PRODUCTION: 3325.9 METRIC TONS STEEL/DAY (3667 TONS STEEL/DAY)
MAKE-UP (BLOWDOWN FROM COOLING TOWER)
MAKE-UP SOFTENER FILTERED WATER
4
37.9 l/SEC (600 GPM)
69.4 l/SEC (1100 GPM)
2
THICKENER
1
MINOR INTERMITTENT FLOWS
LIME FEED (MAINTAIN pH 6.0)
CLARIFIER BASEMENT SUMP
FILTRATE FLOOR DRAIN
VACUUM PUMP COOLING WATER
(SPRAY WATER TO CLEAN FILTER MEDIA)
107.3 l/SEC (1700 GPM)
BLOWDOWN 18.9 l/SEC (300 GPM)
TO SEWER OR DEEP BED FILTER
EVAPORATION 18.9 l/SEC (300 GPM)
3
88.3 l/SEC (1400 GPM)
88.3 l/SEC (1400 GPM)
FILTRATE
GAS SCRUBBER
VACUUM FILTERS
△ SAMPLING POINT


PROCESS: ELECTRIC FURNACE & OPEN HEARTH
PLANT: 042 & 052
PRODUCTION:
ELECTRIC FURNACE - 499 METRIC TONS/DAY (550 TONS/DAY)
OPEN HEARTH-2841 METRIC TONS/DAY (3133 TONS/DAY)
(2) ELECTRIC FURNACES SCRUBBER SYSTEM
PUMP STATION
28.4 l/SEC (450 GPM)
B
28.4 l/SEC (450 GPM)
LIME SLURRY
POLYMER
PHC
FLOCCULATION & NEUTRALIZATION TANK
SPLITTER BOX
69.4 l/SEC (1100 GPM)
FILTRATE
(5) OPEN HEARTHS SCRUBBER SYSTEM
C
FLUSHING WATER
69.4 l/SEC (1100 GPM)
SERVICE WATER MAKE-UP
PUMP STATION
CLARIFIER
CLARIFIER
A
97.8 l/SEC (1550 GPM)
VACUUM FILTERS
D
CLEARWELL
BLOWDOWN TO MILL SETTLING PONDS
69.4 l/SEC (1100 GPM)
SOLIDS TO STOCKPILE FOR FUTURE RECLAMATION
Dwn.6/27/80

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC FURNACE - OPEN HEARTH
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-16


CITY WATER SUPPLY
NON-CONTACT COOLING WATER
TRANSFORMER VAULT
14.1 ℓ/SEC (224 GPM)
TO SEWER
17.7 ℓ/SEC (280 GPM)
FLAME TRAP
FLAME TRAP SUMP
9.1 ℓ/SEC (145 GPM)
8.5 ℓ/SEC. (135 GPM)
MAKE-UP WATER
1.8 ℓ/SEC. (28 GPM)
19.4 ℓ/SEC (308 GPM)
1
2
3
DRAG LINK CONVEYOR
SETTLING TANK
SLUDGE BASIN
POLYMER FEED SYSTEM
MAKE-UP WATER
CITY WATER SUPPLY
NON-CONTACT COOLINGWATER
TRANSFORMER VAULT
14.1 ℓ/SEC. (224 GPM)
TO SEWER
△ SAMPLING POINTS

PROCESS: STEELMAKING (EF)

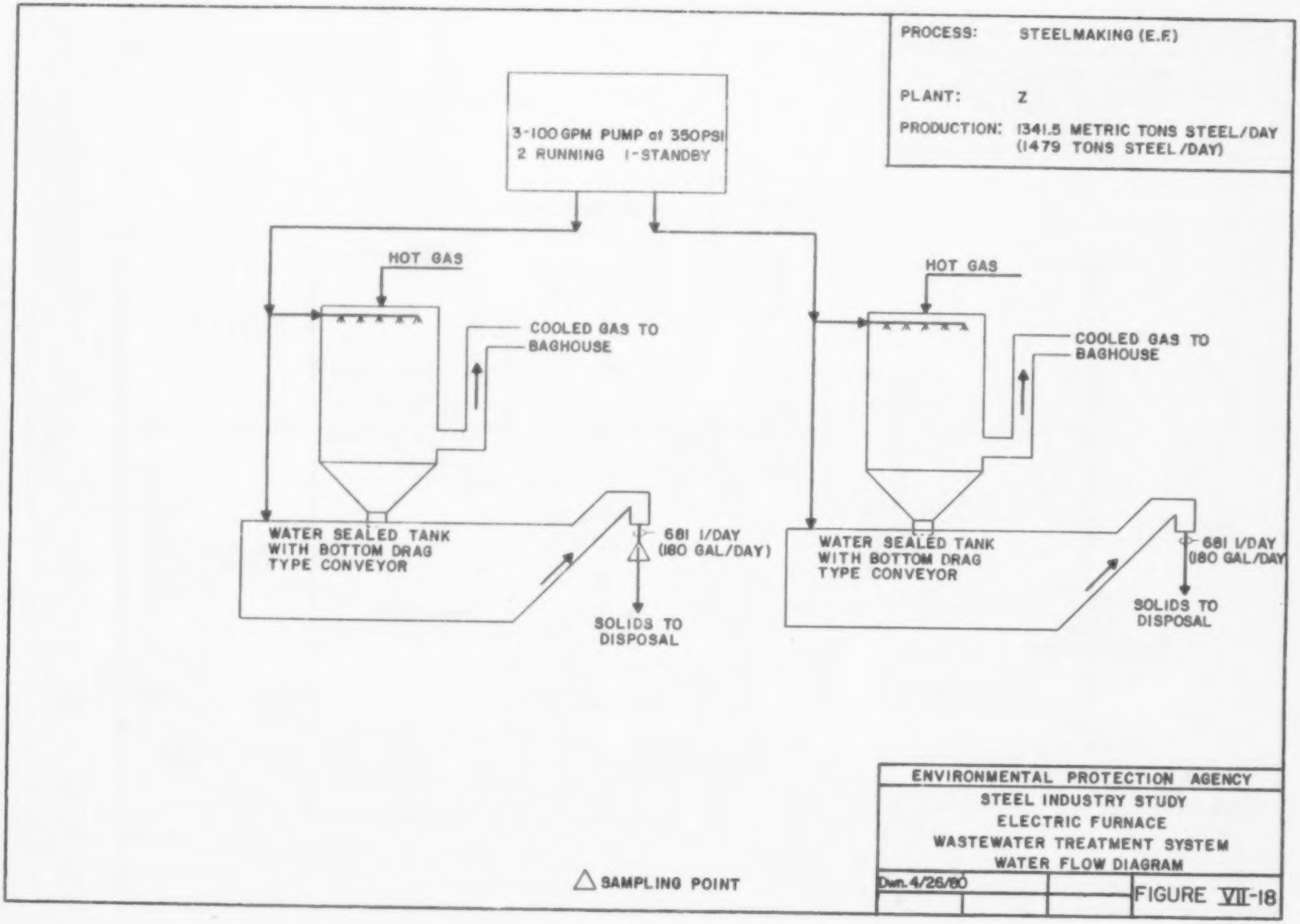
PLANT: Y
PRODUCTION: 1810.4 METRIC TONS STEEL PER DAY
(1996 TONS STEEL PER DAY)

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
ELECTRIC FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

RD4/27/78

FIGURE VIII-17


PROCESS: STEELMAKING (E.F.)

PLANT: Z

PRODUCTION: 1341.5 METRIC TONS STEEL/DAY
(1479 TONS STEEL/DAY)

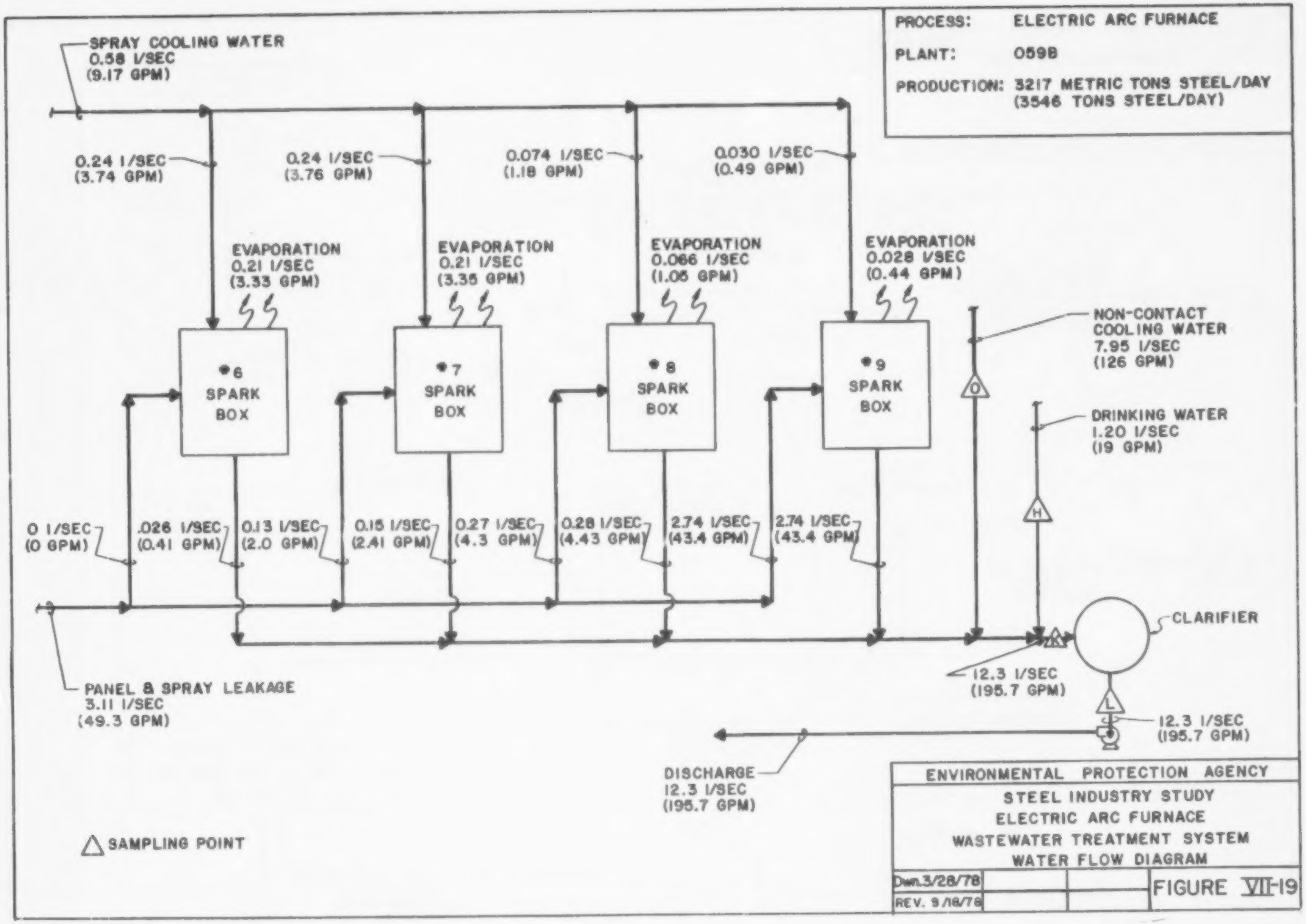
3-100 GPM PUMP at 350 PSI
2 RUNNING 1-STANDBY
HOT GAS
COOLED GAS TO BAGHOUSE
WATER SEALED TANK WITH BOTTOM DRAG TYPE CONVEYOR
681 l/DAY (180 GAL/DAY)
SOLIDS TO DISPOSAL
HOT GAS
COOLED GAS TO BAGHOUSE
WATER SEALED TANK WITH BOTTOM DRAG TYPE CONVEYOR
681 l/DAY (180 GAL/DAY
SOLIDS TO DISPOSAL
△ SAMPLING POINT

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

Dwn. 4/26/80

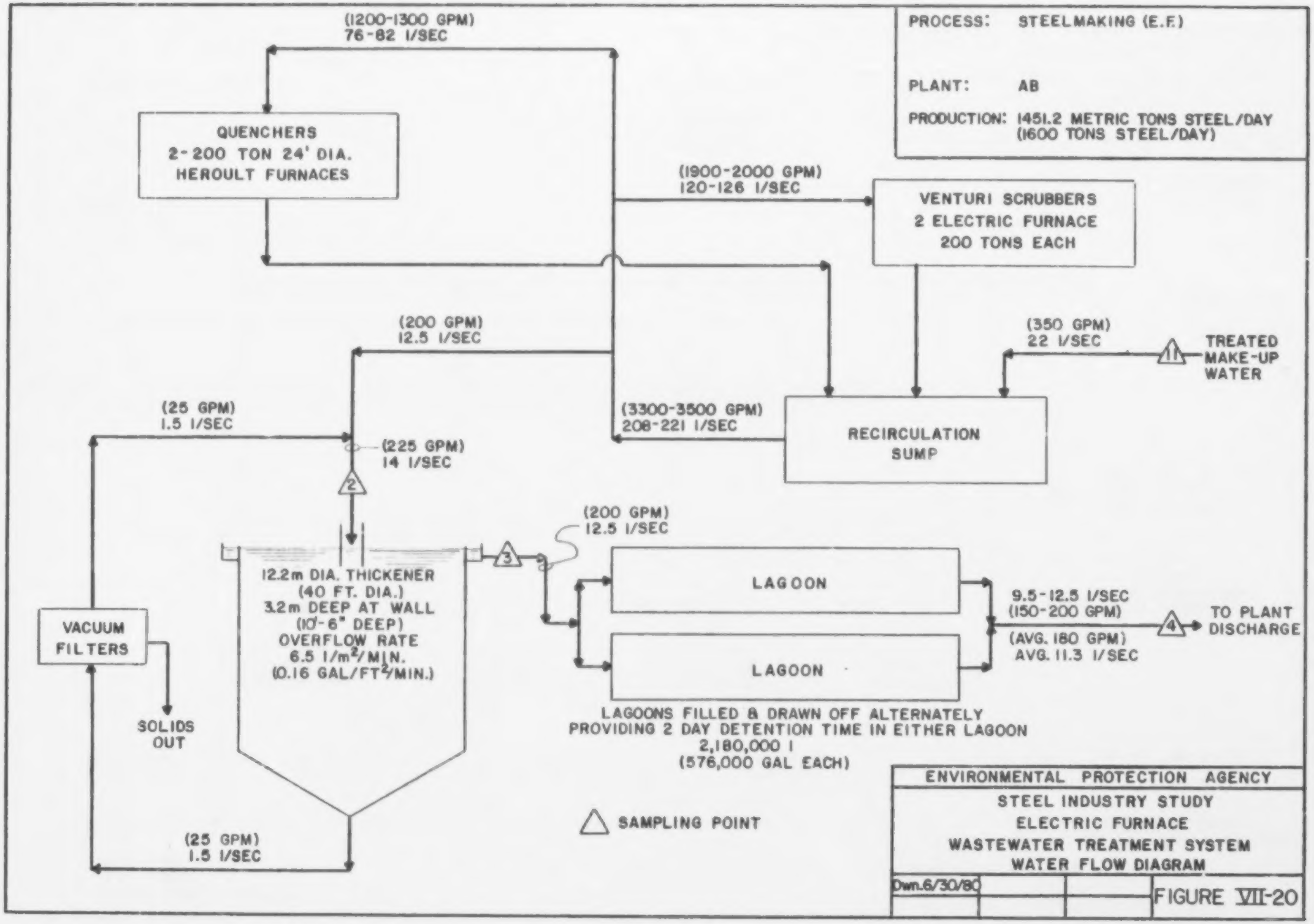
FIGURE VII-18

PROCESS: ELECTRIC ARC FURNACE
PLANT: 059B
PRODUCTION: 3217 METRIC TONS STEEL/DAY
(3546 TONS STEEL/DAY)


SPRAY COOLING WATER
0.58 l/SEC
(9.17 GPM)
0.24 l/SEC
(3.74 GPM)
0.24 l/SEC
(3.76 GPM)
0.074 l/SEC
(1.18 GPM)
0.030 l/SEC
(0.49 GPM)
EVAPORATION
0.21 l/SEC
(3.33 GPM)
EVAPORATION
0.21 l/SEC
(3.35 GPM)
EVAPORATION
0.066 l/SEC
(1.05 GPM)
EVAPORATION
0.028 l/SEC
(0.44 GPM)
*6
SPARK
BOX
*7
SPARK
BOX
*8
SPARK
BOX
*9
SPARK
BOX
NON-CONTACT
COOLING WATER
7.95 l/SEC
(126 GPM)
O
DRINKING WATER
1.20 l/SEC
(19 GPM)
H
0 l/SEC
(0 GPM)
.026 l/SEC
(0.41 GPM)
0.13 l/SEC
(2.0 GPM)
0.15 l/SEC
(2.41 GPM)
0.27 l/SEC
(4.3 GPM)
0.28 l/SEC
(4.43 GPM)
2.74 l/SEC
(43.4 GPM)
2.74 l/SEC
(43.4 GPM)
K
CLARIFIER
PANEL & SPRAY LEAKAGE
3.11 l/SEC
(49.3 GPM)
12.3 l/SEC
(195.7 GPM)
L
12.3 l/SEC
(195.7 GPM)
DISCHARGE
12.3 l/SEC
(195.7 GPM)
△ SAMPLING POINT
Dwn.3/28/78
REV. 9/18/78

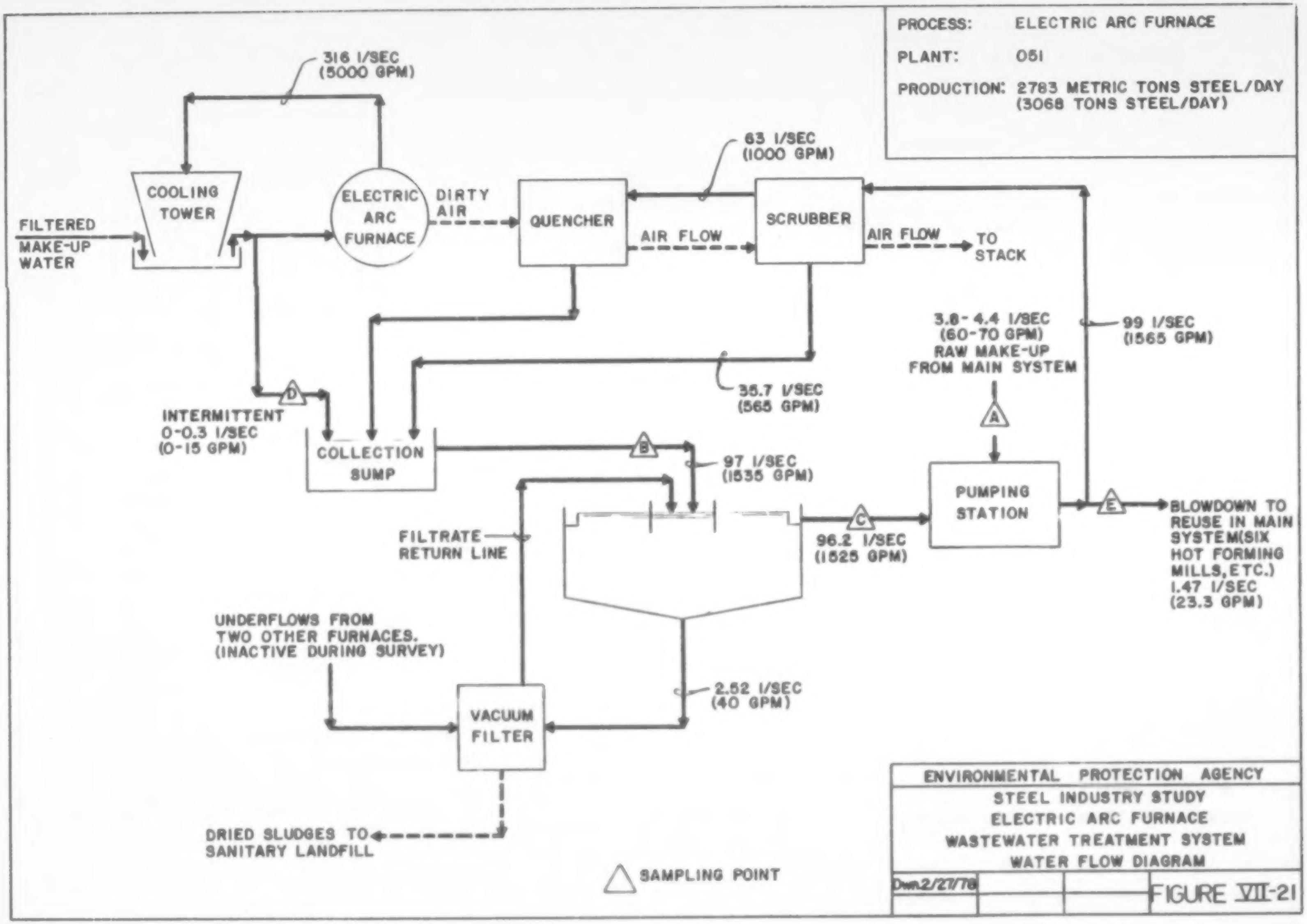
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC ARC FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-19


PROCESS: STEELMAKING (E.F.)
PLANT: AB
PRODUCTION: 1451.2 METRIC TONS STEEL/DAY (1600 TONS STEEL/DAY)
(1200-1300 GPM) 76-82 l/SEC
QUENCHERS 2-200 TON 24' DIA. HEROULT FURNACES
(1900-2000 GPM) 120-126 l/SEC
VENTURI SCRUBBERS 2 ELECTRIC FURNACE 200 TONS EACH
(200 GPM) 12.5 l/SEC
(350 GPM) 22 l/SEC
1
TREATED MAKE-UP WATER
(25 GPM) 1.5 l/SEC
(3300-3500 GPM) 208-221 l/SEC
RECIRCULATION SUMP
(225 GPM) 14 l/SEC
2
(200 GPM) 12.5 l/SEC
3
12.2m DIA. THICKENER (40 FT. DIA.) 3.2m DEEP AT WALL (10'-6" DEEP) OVERFLOW RATE 6.5 l/m²/MIN. (0.16 GAL/FT²/MIN.)
VACUUM FILTERS
SOLIDS OUT
LAGOON
LAGOON
9.5-12.5 l/SEC (150-200 GPM)
(AVG. 180 GPM) AVG. 11.3 l/SEC
4
TO PLANT DISCHARGE
LAGOONS FILLED & DRAWN OFF ALTERNATELY PROVIDING 2 DAY DETENTION TIME IN EITHER LAGOON 2,180,000 l (576,000 GAL EACH)
(25 GPM) 1.5 l/SEC
△ SAMPLING POINT
Dwn.6/30/80

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-20


COOLING TOWER
FILTERED MAKE-UP WATER
316 l/SEC (5000 GPM)
ELECTRIC ARC FURNACE
DIRTY AIR
QUENCHER
63 l/SEC (1000 GPM)
SCRUBBER
AIR FLOW
AIR FLOW
TO STACK
D
INTERMITTENT 0-0.3 l/SEC (0-15 GPM)
COLLECTION SUMP
35.7 l/SEC (565 GPM)
B
97 l/SEC (1535 GPM)
FILTRATE RETURN LINE
C
96.2 l/SEC (1525 GPM)
3.8-4.4 l/SEC (60-70 GPM) RAW MAKE-UP FROM MAIN SYSTEM
A
PUMPING STATION
99 l/SEC (1565 GPM)
E
BLOWDOWN TO REUSE IN MAIN SYSTEM(SIX HOT FORMING MILLS, ETC.) 1.47 l/SEC (23.3 GPM)
UNDERFLOWS FROM TWO OTHER FURNACES. (INACTIVE DURING SURVEY)
2.52 l/SEC (40 GPM)
VACUUM FILTER
DRIED SLUDGES TO SANITARY LANDFILL
SAMPLING POINT
Dwn.2/27/78

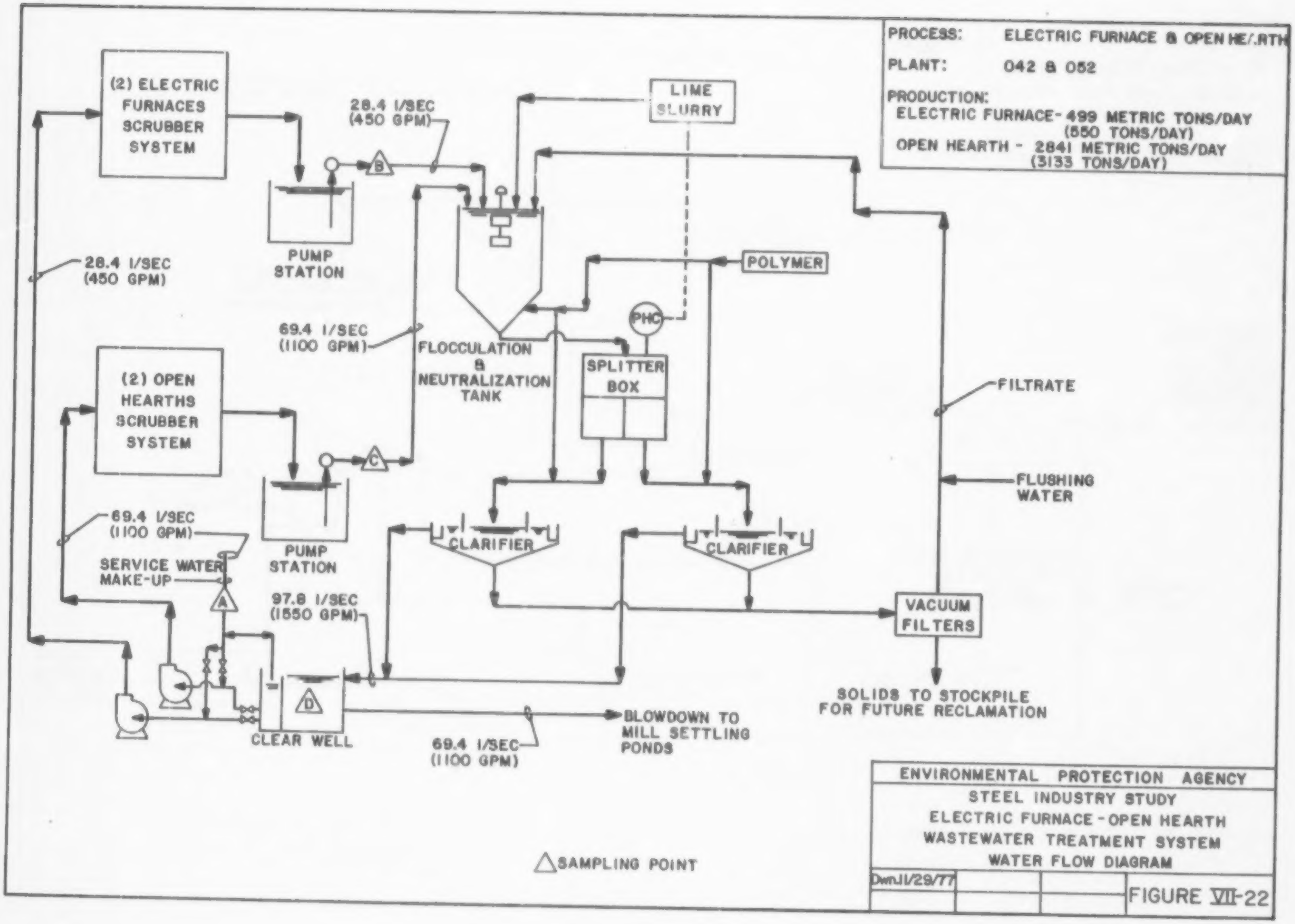
PROCESS: ELECTRIC ARC FURNACE

PLANT: 051

PRODUCTION: 2783 METRIC TONS STEEL/DAY
(3068 TONS STEEL/DAY)

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC ARC FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

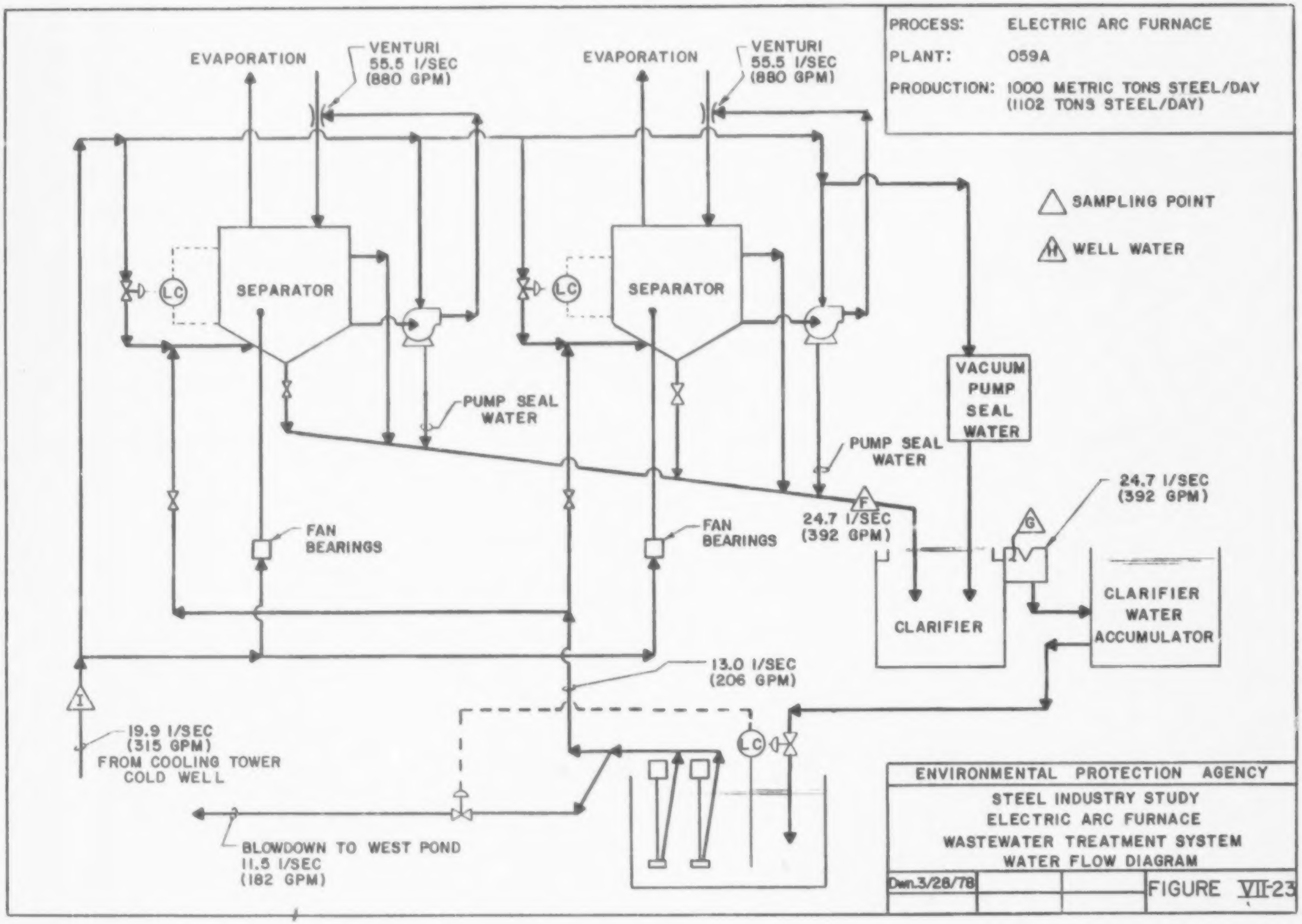
FIGURE VII-21



(2) ELECTRIC FURNACES SCRUBBER SYSTEM
PUMP STATION
28.4 l/SEC (450 GPM)
B
LIME SLURRY
28.4 l/SEC (450 GPM)
69.4 l/SEC (1100 GPM)
FLOCCULATION & NEUTRALIZATION TANK
POLYMER
PHC
SPLITTER BOX
(2) OPEN HEARTHS SCRUBBER SYSTEM
PUMP STATION
C
FILTRATE
FLUSHING WATER
69.4 l/SEC (1100 GPM)
SERVICE WATER MAKE-UP
A
CLARIFIER
CLARIFIER
97.8 l/SEC (1550 GPM)
D
CLEAR WELL
VACUUM FILTERS
SOLIDS TO STOCKPILE FOR FUTURE RECLAMATION
BLOWDOWN TO MILL SETTLING PONDS
69.4 l/SEC (1100 GPM)
△SAMPLING POINT

PROCESS: ELECTRIC FURNACE & OPEN HEARTH
PLANT: 042 & 052
PRODUCTION:
ELECTRIC FURNACE - 499 METRIC TONS/DAY (550 TONS/DAY)
OPEN HEARTH - 2841 METRIC TONS/DAY (3133 TONS/DAY)

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC FURNACE - OPEN HEARTH
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
Dwn.11/29/77
FIGURE VII-22


PROCESS: ELECTRIC ARC FURNACE
PLANT: 059A
PRODUCTION: 1000 METRIC TONS STEEL/DAY (1102 TONS STEEL/DAY)
SAMPLING POINT
WELL WATER
EVAPORATION
VENTURI 55.5 l/SEC (880 GPM)
EVAPORATION
VENTURI 55.5 l/SEC (880 GPM)
LC
SEPARATOR
LC
SEPARATOR
PUMP SEAL WATER
PUMP SEAL WATER
VACUUM PUMP SEAL WATER
F
24.7 l/SEC (392 GPM)
G
24.7 l/SEC (392 GPM)
FAN BEARINGS
FAN BEARINGS
CLARIFIER
CLARIFIER WATER ACCUMULATOR
13.0 l/SEC (206 GPM)
I
19.9 l/SEC (315 GPM) FROM COOLING TOWER COLD WELL
LC
BLOWDOWN TO WEST POND 11.5 l/SEC (182 GPM)
Dwn.3/28/78

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
ELECTRIC ARC FURNACE
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-23

STEELMAKING SUBCATEGORY

SECTION VIII

COST, ENERGY, AND NONWATER QUALITY IMPACT

Introduction

This section presents the incremental costs incurred in the application of the alternative treatment systems for steelmaking operations. The analyses also include the energy requirements, the nonwater quality impacts, and the techniques, magnitude, and costs associated with the application of the BPT model and BAT, NSPS, PSES, and PSNS alternative treatment systems. In addition, the solids generation rates, the BCT cost comparison, and the consumptive use of water are addressed.

Actual Costs Incurred by the Plants Sampled or Solicited for this Study

The water pollution control costs supplied by the industry for those steelmaking operations sampled during the original and toxic pollutant surveys or through the D-DCPs are presented in Tables VIII-1 through VIII-7. These costs have been updated from the costs provided by the plants, to July 1, 1978 dollars. In several instances, the costs reported by the industry represented total expenditures for combined wastewater treatment systems or for entire gas cleaning and wastewater treatment systems. Where possible, these costs were analyzed and apportioned to determine the costs attributable to wastewater treatment. However, this could not be done in all cases. In those instances, the costs were not used in the cost analysis or comparison.

The usable capital cost data from the steelmaking plants noted above were compared with the estimated expenditures, factored on the basis of production from the treatment model costs, for these plants. This comparison demonstrates that costs for the treatment models are sufficient to account for the various site-specific and other incidental costs. A tabulation of the usable cost data reported by the industry (refer to Tables VIII-1 through VIII-7), and the estimated expenditures of these steelmaking plants follows.

Process	Plant No.	Actual Costs	Estimated Costs
BOF - Semi-wet	0432A	$ 692,000	$ 1,614,000
	0396D	1,917,000	909,000
BOF - Wet-Suppressed Combustion	0060	2,994,000	3,144,000
	0384A	5,875,000	2,212,000
	0684H	3,329,000	3,064,000
BOF - Wet-Open Combustion	0856B	2,848,000	3,822,000
	0868A	7,248,000	4,442,000
Open Hearth - Semi-wet	0864A	2,488,000	2,863,000
Open Hearth - Wet	0060	3,331,000	4,903,000
	0112A	1,134,000	5,401,000
	0492A	866,000	3,515,000
EAF - Semi-wet	0432C	590,000	584,000
	0584A	231,000	287,000
EAF - Wet	0060F	586,000	1,927,000
	0492A	406,000	1,527,000
	0612	910,000	5,148,000
	0868B	2,163,000	2,377,000
TOTAL		$37,608,000	$47,739,000

Referring to the above data, for 71% of the plants the Agency's estimated costs are greater than the actual costs reported by industry. The most noteworthy comparison, however, is that the total estimated cost for the steelmaking operations listed is about 25% higher than the total actual cost, indicating that EPA costing for the steelmaking subcategory is sufficiently generous to account for site-specific and retrofit costs. Reference is made to Volume I for further verification of the applicability of the treatment model costs.

Control and Treatment Technologies (C&TT)

Reviews of the treatment components included in the BPT model and BAT alternative treatment systems are presented in Tables VIII-8 through VIII-10. It should be noted that the proposed limitations do not require the installation of the model treatment systems; any treatment system which achieves the proposed limitations is acceptable. The following items are described in Tables VIII-8 through VIII-10.

1. Status and reliability
2. Problems and limitations
3. Implementation time
4. Land requirements
5. Environmental impacts other than water
6. Solid waste generation

Cost, Energy, and Nonwater Quality Impacts

General Introduction

The installation of BPT, BAT, BCT, NSPS, PSES, and PSNS model and alternative treatment systems will involve additional funding (both investment and operating) and energy requirements, and also requires consideration of any air pollution, water consumption, and solid waste disposal impacts associated with each treatment system. The Agency's estimates of the costs and energy requirements are based upon the alternative treatment systems developed in Sections IX through XIII of this report and are presented in the tables and text of this section.

Estimated Costs for the Installation of Pollution Control Technologies

A. Costs Required to Achieve the Proposed BPT Limitations

The first step in determining the estimated costs of compliance involved the development of model treatment systems upon which cost estimates could be based. The Agency developed the model sizes (tons/day) based upon the average production capacities for all plants within each segment of the steelmaking subdivisions. The applied flow for each model treatment system was determined in the same fashion. The components and effluent flows discussed in Sections IX and X were incorporated to complete the development of the treatment systems. The unit costs for each treatment model component were then developed. Tables VIII-15 through VIII-21 present the estimated capital and annual costs for the BPT model treatment systems in each steelmaking segment. The capital requirements needed to achieve the proposed BPT limitations for the steelmaking segments were determined by applying the treatment component model costs, adjusted for size, to the treatment equipment requirements of each plant. Estimates of expenditures required to bring these operations from current (January 1, 1978) treatment levels to the BPT model treatment levels were necessary to assess the cost of the various effluent limitations to the industry. Tables VIII-22 through VIII-28 summarize the estimated in-place and required expenditures for each plant within the steelmaking segments. The estimated capital requirements and annual costs of BPT for all plants within each segment of the three steelmaking subdivisions are presented below.

	Estimated Expenditures		
Steelmaking Subdivision	In-place	Required	Estimated Annual Cost
BOF-Semi-Wet	$ 8,400,000	$ 4,150,000	$ 2,980,000
BOF-Wet-Suppressed Combustion	16,360,000	2,560,000	2,590,000
BOF-Wet-Open Combustion	64,650,000	11,210,000	19,050,000
Open Hearth-Semi-wet	2,860,000	640,000	850,000
Open Hearth-Wet	13,820,000	2,380,000	3,810,000
EAF-Semi-wet	1,350,000	570,000	420,000
EAF-Wet	20,360,000	2,500,000	8,330,000
TOTAL	$127,800,000	$24,010,000	$38,030,000

The estimated annual costs were determined by multiplying the treatment model annual costs for each segment by the number of plants in that segment.

B. Costs Required to Achieve the Proposed BAT Limitations

The Agency considered three alternative treatment systems in each wet air pollution control system segment. As the BPT model treatment system for each semi-wet segment provided for the elimination of process wastewater pollutant discharges to navigable waters, the Agency did not consider additional BAT alternative treatment systems in these segments. The descriptions, rationale, and additional details for the various alternatives are provided in Section X. The additional investment and annual expenditures involved in applying each of the BAT alternatives to the BPT model treatment system are presented in Tables VIII-29 through VIII-32. The additional capital requirements for each segment within the steelmaking subdivisions were determined by multiplying the unit costs for each component (as developed in the treatment model) by the number of plants within each segment which require that component. Total annual costs for BAT in each segment were derived by multiplying each segment's model annual costs by the number of plants within that segment. The estimated investment and annual costs for each steelmaking segment's BAT alternative treatment system are presented in Table VIII-33.

C. BCT Cost Test

The BCT cost analyses for the steelmaking wet segments are presented in Tables VIII-34 through VIII-37. Refer to Section XI for a detailed review of BCT.

D. Cost Required to Achieve NSPS

As the BPT model treatment systems for the semi-wet air pollution control system segments involve no discharge of process wastewater pollutants to navigable waters, only a single treatment model (identical to the BPT model treatment system) was developed in each semi-wet segment for those new semi-wet facilities constructed after the proposal of New Source Performance Standards. The Agency did not develop a model treatment system for the open hearth - semi-wet segment since new open hearth furnaces are not likely to be constructed in this country. The NSPS treatment model costs for the remaining semi-wet segments are presented in Tables VIII-38 and VIII-39. It should also be recognized that either dry or wet air pollution control systems will be selected for most new steelmaking operations, both of which offer advantages over semi-wet systems.

The Agency developed three NSPS alternative treatment systems for each wet segment except for the open hearth wet segment. The NSPS alternative treatment systems for each wet segment are identical to the respective BPT and BAT alternative treatment systems. The NSPS treatment model costs for the remaining three wet gas cleaning system segments are presented in Tables VIII-40 through VIII-42. The model sizes used for the BAT alternative treatment systems were retained for use in the NSPS alternative treatment systems, as the average sizes of those plants built in the last decade in each wet segment were within ten percent of the BAT treatment model sizes.

E. Costs Required to Achieve the Pretreatment Standards

Pretreatment standards apply to those plants which continue or elect to discharge to POTW systems. The pretreatment alternative treatment systems for the semi-wet and wet air pollution control system segments are identical to the respective BPT and BAT alternative treatment systems in each segment (refer to Section X for a review of the alternatives). These systems provide for reductions in effluent flows and in the effluent levels and loads of those pollutants of concern in POTW systems. Refer to Section XIII for additional information pertaining to pretreatment standards. The pretreatment model costs for the semi-wet systems are identical to the BPT model costs for these systems (refer to Tables VIII-15, VIII-18, and VIII-20). The model costs for the wet BOF and EAF pretreatment systems are the same as the costs for the respective NSPS treatment systems (refer to Table VIII-40 through VIII-42). The pretreatment model costs for the wet open hearth segment are presented in Table VIII-43.

Energy Impacts Due to the Installation of the Incorporated Technologies

Moderate amounts of energy will be required by the various levels of treatment in the steelmaking segments. The major energy expenditures in each segment will be required at the BPT level of treatment while the BAT alternative treatment systems require only minor additional energy expenditures. The vacuum filters incorporated in the BPT model treatment systems require significantly greater amounts of energy than any other treatment component. This relationship, in turn, is responsible for the difference in energy expenditures between the BPT and BAT treatment systems in each segment. Energy requirements at NSPS and PSNS will be similar to those for the corresponding BPT and BAT systems. PSES energy requirements are included in the BPT and BAT energy requirements.

A. Energy Impacts at BPT

Table VIII-44 presents the estimated annual energy requirements associated with the proposed BPT limitations for all plants within each segment. This table also presents the relationships between these energy requirements and the 57 billion kilowatt hours of electricity used by the steel industry in 1978.

B. Energy Impacts at BAT

Table VIII-44 also presents the estimated annual energy requirements, and their comparison to the power usage for the industry, needed to upgrade from the BPT model treatment system to the BAT alternative treatment systems for all plants within each segment. In reviewing these data, the Agency concludes that the energy requirements are reasonable when compared to total industry power consumption and that the effluent reduction benefits justify any negative impacts of the additional energy consumption.

C. Energy Impacts at NSPS and Pretreatment

Following are the energy requirements for the semi-wet gas cleaning system NSPS, PSES, and PSNS alternative treatment systems.

Segment	kwh per Year
BOF - Semi-wet	0.34 million
Open Hearth - Semi-wet	1.29 million*
EAF - Semi-wet	0.38 million

*: Energy requirement at the PSES level only.

Table VIII-45 presents the energy requirements for the wet gas cleaning systems NSPS and Pretreatment alternative treatment systems. The Agency did not calculate the total impacts for NSPS and Pretreatment since projections of the number of new steelmaking operations were not made as part of this study. As noted earlier, only one steelmaking operation is discharging wastewaters to a POTW. The energy impacts of this facility are included in those for BPT and BAT.

Nonwater Quality Impacts

In general, the nonwater quality impacts associated with the alternative treatment systems are minimal. The three impacts which were evaluated are air pollution, solid waste disposal, and water consumption.

A. Air Pollution

The Agency does not expect that any adverse air pollution impacts will occur as a result of the use of any of the BPT model treatment system components.

As sulfide addition is incorporated in the BAT Alternative No. 3 treatment systems, atmospheric discharges could occur in the event of treatment process control upsets. However, as the steelmaking process wastewaters would not typically be acidic at the point of sulfide addition, the possibility of atmospheric sulfide discharges, which are aggravated at an acidic pH, would be minimized. In addition, atmospheric sulfide discharges could be controlled by using a ferrous sulfide slurry as the source of sulfide for toxic metals precipitation.

As the Agency has not selected BAT Alternative No. 3 as the BAT model treatment system for any of the segments and the components which are incorporated in the selected BAT model treatment systems (refer to Section X), will not result in any adverse air pollution impacts, the Agency believes that implementation of the proposed BAT limitations will have no significant adverse air pollution impacts.

B. Solid Waste Disposal

The treatment steps included in the BPT model and BAT alternative treatment systems will generate quantities of solid wastes which must be disposed of properly. These solid wastes will consist essentially of the solids removed from the processes, although treatment chemicals will comprise a small portion of the total solid waste load. It should be noted that the solids generated in the process can be reclaimed in sintering or pelletizing operations, and, thus, the impact of solid waste disposal can be significantly reduced. Moreover, nearly all of these solid wastes are generated at the BPT level of treatment. Almost all steelmaking operations are presently achieving this level and disposing of these solid wastes. Consequently, the Agency believes that the incremental effect of this proposed regulation will be minimal. Table VIII-14 presents a summary of the solid waste generation rates by the BPT model and BAT alternative treatment systems for all of the plants in each segment of the steelmaking subdivisions. As noted on this table, the quantities of solid wastes generated by the BAT alternative treatment systems are significantly less than the amounts generated at the BPT level.

The estimated quantities of solid wastes generated by the NSPS and Pretreatment models are presented on Table VIII-46. As noted previously in this section, the NSPS and Pretreatment models are identical to the corresponding BPT model and BAT alternative treatment systems. The solid wastes generated at the NSPS and Pretreatment levels are of the same nature and present the same possibilities for reuse, and the same disposal requirements, as the solid wastes generated by the BPT and BAT treatment systems.

C. Water Consumption

Evaporative cooling is not included as a treatment step in the steelmaking segments, and those treatment steps which are included are essentially not water consumptive. As a result, the Agency does not believe that there will be any significant adverse impacts with respect to water consumption at any level of treatment.

Summary of Impacts

In summary, the Agency concludes that the pollutant reduction benefits described below for the steelmaking subcategory justify any adverse energy and nonwater quality environmental impacts:

	Effluent Discharges (Tons/Year)		
	Raw Waste	Proposed BPT	Proposed BAT & BCT
Flow, MGD	284	13.5	13.5
TSS	1,258,000	1029	315
Toxic Metals	25,130	127	25
Fluoride	16,420	638	252

NOTE: PSES discharges are included in those for BPT and BAT.

TABLE VIII-1

EFFLUENT TREATMENT COSTS
BASIC OXYGEN FURNACE - SEMI-WET

(All costs are expressed in July, 1978 dollars.)

Plant Code	R	U
Reference Code	0432A Original Survey	0396D Original Survey
Initial Investment	$692,000	$1,917,000
Annual Costs		
Cost of Capital	$ 29,763(1)	$ 82,441(1)
Depreciation	69,216(2)	191,724(2)
Operation and Maintenance	683,508	Not Available
Energy and Power	Incl.	Not Available
Other (sludge, etc.)	Not Available	Not Available
TOTAL	$782,487	$ 274,165
$/Ton	0.251	0.253
$/1000 Gal. Treated	1.93	0.348

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(1) Cost of capital was calculated by using the following formula: (0.043) x (Initial Investment).

(2) Depreciation was calculated by using the following formula: (0.10) x (Initial Investment).

TABLE VIII-2

EFFLUENT TREATMENT COSTS
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

(All costs are expressed in July, 1978 dollars.)

Plant Code	S	032		034		038	-
Reference Code	0060	0384A		0856N		0684F	0684H
	Original Survey	Toxics Survey	D-DCP	Toxics Survey	D-DCP	Toxics Survey	D-DCP
Initial Investment	$2,994,000	$5,907,000	$5,875,000	$13,264,000(3)	$13,390,000(3)	$9,690,000(4)	$3,329,000
Annual Costs							
Cost of Capital	128,724(1)	254,012(1)	252,625(1)	-	-	-	143,163(1)
Depreciation	299,359(2)	590,726(2)	587,518(2)	-	-	-	160,063(5)
Operation and Maintenance	124,939	474,418	519,633	-	-	-	247,878
Energy, Power, Chemicals, etc.	91,361	400,979	374,247	-	-	-	29,657
Other (Sludge, etc.)	-	-	158,493	-	-	-	-
Other (equipment rental, contract labor, freight, etc.)	-	-	43,056	-	-	-	26,850
TOTAL	$ 644,383	$1,720,135	$1,935,572	-	-	-	$ 607,611
$/Ton	0.278	1.07	0.782	-	-	-	0.261
$/1000 Gal. Treated	0.271	0.728	2.77	-	-	-	1.02

---

(1) Cost of capital was calculated by using the following formula: (0.043) x (Initial Investment).
(2) Depreciation was calculated by using the following formula: (0.10) x (Initial Investment).
(3) Costs include expenditures for hoods and gas cleaning systems. Expenditures for water pollution control facilities cannot be separated.
(4) Treatment is provided primarily in a central treatment system. This investment cost represents the estimated portion of the total cost required by the BOF process. A detailed estimate could not be obtained.
(5) Depreciation was based upon 20 year straight line.

TABLE VIII-3

EFFLUENT TREATMENT COSTS
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

(All costs are expressed in July, 1978 dollars)

Plant Code	T	V		031	
Reference Code	0112A	0584F		0020B	
	Original Survey	Original Survey	D-DCP	Toxics Survey	D-DCP
Initial Investment Cost	-	9,313,000(1)	9,723,000(1)	829,000	*
Annual Costs					
Cost of Capital	-	-	-	35,653(2)	*
Depreciation	-	-	-	82,915(3)	*
Operation & Maintenance	13,943	-	-	143,891	*
Energy & Power, Chemicals, etc.	222,892	-	-	22,145	*
TOTAL	236,385	-	-	284,604	*
$/Ton	-	-	-	0.364	*
$/1000 Gal Treated	-	-	-	0.344	*

Plant Code	033	035	036	-	-
Reference Code	0856B	0868A	0112D	0724A	0860B
	Toxics Survey	Toxics Survey	Toxics Survey	D-DCP	D-DCP
Initial Investment Cost	2,848,000	7,248,000	16,827,000(4)	-	19,615,000(5)
Annual Cost					
Cost of Capital	122,479(2)	311,647(2)	-	-	-
Depreciation	284,836(3)	724,760(3)	-	-	-
Operation & Maintenance	457,884	607,597	-	-	-
Energy & Power, Chemicals, etc.	1,027,474	264,504	-	-	-
TOTAL	1,892,673	1,908,508	-	-	-
$/Ton	0.663	0.816	-	-	-
$/1000 Gal/Treated	2.75	0.734	-	-	-

---

(1) Costs, as presented, represent expenditures for the entire BOF shop. Wastewater treatment costs could not be separated.

(2) Cost of capital was calculated by using the following formula:
(0.043) x (initial investment)

(3) Depreciation was calculated by using the following formula:
(0.10) x (initial invesment)

(4) BOF wastewater treatment expenditures could not be determined because the data, as reported, represented capital expenditures for wastewater treatment and/or gas cleaning facilities.

(5) The data, as provided, represents combined expenditures for gas cleaning (hoods, etc.) and wastewater treatment facilities.

*: Confidential information.
-: Not available.

TABLE VIII-4

EFFLUENT TREATMENT COSTS
OPEN HEARTH - SEMI-WET

(All costs are expressed in July, 1978 dollars.)

Plant Code	043	
Reference Code	0864A	
	Toxics Survey	D-DCP(3)
Initial Investments	2,212,000	2,488,000
Annual Costs		
Cost of Capital	95,116(1)	-
Depreciation	221,200(2)	-
Operation and Maintenance	846,090	-
Energy and Power	590,604	-
TOTAL	1,753,010	
$/Ton	0.733	
$/1000 Gal. Treatment	0.733	

---

(1) Cost of capital was calculated by using the following formula: (0.043) x (Initial Investment).

(2) Depreciation was calculated by using the following formula: (0.10) x (Initial Investment).

(3) Operating costs were not reported.

TABLE VIII-5

EFFLUENT TREATMENT COSTS
OPEN HEARTH - WET

(All costs are expressed in July, 1978 dollars.)

Plant Code	W		X		042
Reference No.	0112A		0060		0492A
	Original Survey	D-DCP	Original Survey	D-DCP	Toxics Survey
Initial Investment	1,685,000	1,134,000	3,331,000	3,323,000	866,000(7)
Annual Costs		(6)			
Cost of Capital	72,472(1)	560,013(3)	143,234(1)	37,252(1)	
Depreciation	168,539(2)	236,592(4)	333,102(2)	(5)	37,252(1)
Operation and Maintenance	13,184	856,353	239,681		86,633(2)
Energy and Power	223,098	494,134	10,712		66,332
Sludge Handling	-	6,920	-		-
Chemical Costs	-	-	-		-
TOTAL	447,293	2,154,012	726,729		377,986
$/Ton	0.113	0.545	0.362		0.270
$/1000 Gal. Treated	0.213	1.025	0.165		1.598

---

(1) Cost of capital was calculated by using the following formula: (0.043) x (Initial Investment).
(2) Depreciation was calculated by using the following formula: (0.10) x (Initial Investment).
(3) Capital recovery based on 15 year life at 10% cost of capital.
(4) Straight line depreciation over 18 year life.
(5) No annual costs were available.
(6) Annual costs include the costs for 2 High energy scrubber systems which cannot be separated from the total.
(7) The costs for this plant were obtained by apportioning the combined open hearth and EAF wastewater treatment costs.

TABLE VIII-6

EFFLUENT TREATMENT COSTS
ELECTRIC ARC FURNACES - SEMI-WET

(All costs are expressed in July, 1978 dollars.)

Plant Code	Y	Z
Reference Code	0432C	0584A
	Original Survey	Original Survey
Initial Investment	590,000	231,000
Annual Costs		
Cost of Capital	25,373(1)	9,916(1)
Depreciation	59,009(2)	23,062(2)
Operation and Maintenance	9,682	5,356
Energy and Power	27,295	1,030
TOTAL	121,359	39,364
$/Ton	0.17	0.07
$/1000 Gal. Treated	0.61	*

---

(1) Cost of capital was calculated by using the following formula: (0.043) x (initial investment).

(2) Depreciation was calculated by using the following formula: (0.10) x (initial investment).

*: Cannot be determined, as the flow to the treatment system could not be measured.

TABLE VIII-7

EFFLUENT TREATMENT COSTS
ELECTRIC ARC FURNACES - WET

(All costs are expressed in July, 1978 dollars.)

Plant Code	AA/059A[1]	AB	051		052	
Reference Code	0060F	0868B	0612		0492A	0060D
	Original Survey	Original Survey	Toxics Survey	D-DCP	Toxics Survey	D-DCP
Initial Investment	586,000	2,163,000	1,610,000	10,000[2]	406,000[5]	4,347,000[6]
Annual Costs						
Cost of Capital	25,188[3]	93,009[3]	39,130[3]	-	17,477[3]	-
Depreciation	58,576[4]	216,300[4]	91,000[4]	-	40,644[4]	-
Operation and Maintenance	154,397	595,134	120,510	-	76,632	-
Energy and Power	Incl.	-	20,600	-	27,089	-
TOTAL	238,161	904,443	271,240	-	161,842	-
$/Ton	0.59	1.55	0.38	-	0.86	-
$/1000 Gal. Treated	0.26	7.64	0.16	-	0.68	-

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(1) Cost data was obtained during the original guidelines survey. No cost data was provided for the toxic pollutant survey.

(2) This figure represents the company's estimate of water pollution control costs. The company reported that operating costs could not be separated between water and air pollution control costs.

(3) Cost of capital was calculated by using the following formula: (0.043) x (Initial Investment).

(4) Depreciation was calculated by using the following formula: (0.10) x (Initial Investment).

(5) The costs for this plant were obtained by apportioning the combined open hearth and EAF wastewater treatment costs.

(6) The data presented in the D-DCP response represents an apportionment performed by the respondent, of a combined treatment system. The respondent stated that these costs would not be representative of an EAF wastewater treatment system.

TABLE VIII-8

CONTROL AND TREATMENT TECHNOLOGIES BASIC OXYGEN FURNACE SUBDIVISION

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
A. Thickener - This component provides a substantial reduction (via gravity sedimentation) in the wastewater suspended solids load.	Very widely used in the various segments of this subdivision and in wastewater treatment applications in the other steelmaking subdivisions, in this industry, and in other industries.	Hydraulic surges must be controlled. Routine or continuous sludge removal must also be provided in order to prevent excessive solids accumulations which could damage the rake drive and hinder the removal of sludge.	15 to 18 months	Refer to Table VIII-11	The solids removed from the thickener and delivered to the vacuum filter must ultimately receive proper disposal, although these solids could be processed (pelletizing, etc.) for reuse.	Refer to Table VIII-14 for the solid waste generation rates for the various treatment models. These solids consist primarily of the various metal oxides (principally iron oxide) generated in the steelmaking process.
B. Coagulant Aid Addition - Coagulant aids (polymeric flocculants, etc.) are added to the process wastewater influent to the thickener to enhance the sedimentation of suspended particulate matter.	Widely used in this subdivision, in other subcategories in this industry, and in other industries.	Dissolved solids levels may be increased.	6 months	Refer to Table VIII-11	Results in a minor increase in the quantities of solids which must subsequently receive proper disposal.	Solid waste generation rates for this step are included in the values presented on Table VIII-14. The solid waste constituents of this step are similar to the solid waste constituents of Step A.
C. Vacuum Filter - Used to dewater the sludges removed in Step A, thus reducing the mass and volume of solids requiring further handling or disposal. The filtrate is returned to the thickener.	Widely used in this subdivision and in other wastewater treatment applications in this industry and in other industries.	Routine maintenance of vacuum pumps and filter mechanical equipment is required. The filter media must be replaced periodically.	15 to 18 months	Refer to Table VIII-11	The dewatered solids must receive proper disposal.	Refer to the solid waste generation rates presented on Table VIII-14. The nature of the solids in the filter cake is the same as that of the solids removed in Step A.

TABLE VIII-8
CONTROL AND TREATMENT TECHNOLOGIES
BASIC OXYGEN FURNACE SUBDIVISION
PAGE 2

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
D. Recycle - In the semi-wet treatment model, all of the thickener effluent is returned to the process. In the wet-suppressed combustion and wet-open combustion treatment models, a major portion of the thickener effluent is returned to the process.	Used widely in the segments of this subdivision and in other subcategories in this industry. Treatment model recycle rates are defined by the treatment model applied and effluent flows, which in turn, are based on actual performance in each segment (refer to Sections IX and X).	The potential exists for scaling and plugging due to the increased dissolved solids concentrations associated with the recycle of process wastewaters.	12 to 14 months	Refer to Table VIII-11	None	None
E. Neutralization with Acid - Acid is added to the typically alkaline BOF process wastewaters to adjust the wastewater pH to the neutral range (6.0 to 9.0).	Acid addition for the purpose of pH control is demonstrated in this subdivision and in many applications in this industry and in other industries.	Extreme caution must be used in handling the acid. The acid feed and pH control systems require routine maintenance. Dissolved solids concentrations will be increased.	8 to 10 months	Refer to Table VIII-11	Acid fumes must be exhausted from the workplace atmosphere.	None
F. Filtration - Used to provide additional suspended solids removal capability. Additional suspended solids removal will also provide additional removal of those pollutants (i.e., toxic metals) entrained in the suspended solids.	Used in this subdivision. In addition, the capabilities of this technology are well demonstrated in other subcategories in this industry and in other industries.	Hydraulic overloads must be controlled. Poor backwashing will impede efficient filter operation.	15 to 18 months	Refer to Table VIII-11	The backwashed solids must eventually receive proper disposal.	Solid waste generation values for this step are included in the values presented in Table VIII-14. The nature of the backwash solids is the same as that of the solids removed via gravity sedimentation in the thickener.

TABLE VIII-8
CONTROL AND TREATMENT TECHNOLOGIES
BASIC OXYGEN FURNACE SUBDIVISION
PAGE 3

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
G. Flocculation with Lime - Lime not only precipitates a portion of the fluoride waste load (as calcium fluoride), but also results in an additional reduction of the toxic metals load in the recycle system blowdown.	Lime flocculation is employed in wastewater treatment operations in this subdivision, in the other steelmaking subdivisions, in this industry, and in other industries.	Dissolved solids levels in the effluent will be increased.	12 months	Refer to Table VIII-11	Additional solids generated as a result of this step must receive proper disposal. Lime dusts must be exhausted from the workplace atmosphere.	Solid waste generation values for this step are included in the data presented in Table VIII-14. The solids generated as a result of incorporating this step would be removed in Step H. This step's solid wastes would consist of lime solids, calcium fluoride precipitates, and metallic hydroxide precipitates. As they settle, solids may also capture some of the process wastewater suspended particulate matter.
H. Inclined Plate Separator - This step provides for the gravity sedimentation of the suspended particulate matter added by and/or generated in Step G (flocculation with lime).	This technology is employed in this subdivision and is also used widely in other subcategories in this industry and in other industries.	Abrupt process upsets must be controlled. Sludge accumulation must be closely monitored to insure that adequate sludge withdrawal is maintained.	10 to 12 months	Refer to Table VIII-11	The solids generated and/or added in Step G, and then removed in this step, must receive proper disposal.	Solid waste generation values for this step are included in the values presented on Table VIII-14. The composition of the solid wastes removed in this step is described above in Step G.

TABLE VIII-8
CONTROL AND TREATMENT TECHNOLOGIES
BASIC OXYGEN FURNACE SUBDIVISION
PAGE 4

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
I. Sulfide Precipitation - A sulfide source is added to the wastewater stream in order to form metallic sulfide precipitates which are subsequently removed via filtration (refer to Step F).	Used in a variety of industrial wastewater treatment applications for the purpose of providing additional toxic metals removal capabilities.	Care must be exercised in the handling and use of the feed solutions. Tight treatment process control is essential.	6 months	Refer to Table VIII-11	The resultant metal sulfide precipitates require proper disposal. Sulfide odors can result if adequate treatment process control is not provided.	Solid waste generation values for this treatment component are included in the values presented on Table VIII-14. The solid wastes generated in this step consist of the sulfide precipitates of iron and the toxic metals.

NOTE: Steps A through D are common to the semi-wet, wet-suppressed combustion, and wet-open combustion treatment models.
Steps E through I apply to the wet-suppressed combustion and wet-open combustion treatment models only.

TABLE VIII-9

CONTROL AND TREATMENT TECHNOLOGIES OPEN HEARTH FURNACE SUBDIVISION

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
A. Thickener - This component provides a substantial reduction (via gravity sedimentation) in the wastewater suspended solids load.	Very widely used in the segments of this subdivision and in wastewater treatment applications in the other steelmaking subdivisions, in this industry, and in other industries.	Hydraulic surges must be controlled. Routine or continuous sludge removal must also be provided in order to prevent excessive solids accumulations which could damage the rake drive and hinder the removal of sludge.	15 to 18 months	Refer to Table VIII-12	The solids removed from the thickener and delivered to the vacuum filter must ultimately receive proper disposal, although these solids could be processed (pelletizing, etc.) for reuse.	Refer to Table VIII-14 for the solid waste generation rates for the various treatment models. These solids consist primarily of the various metal oxides (principally iron oxide) generated in the steelmaking process.
B. Coagulant Aid Addition - Coagulant aids (polymeric flocculants, etc.) are added to the process wastewater influent to the thickener to enhance the sedimentation of suspended particulate matter.	Widely used in this subdivision, in other subcategories in this industry, and in other industries.	Dissolved solids levels may be increased.	6 months	Refer to Table VIII-12	Results in a minor increase in the quantities of solids which must subsequently receive proper disposal.	Solid waste generation rates for this step are included in the values presented on Table VIII-14. The solid waste constituents of this step are similar to the solid waste constituents of Step A.
C. Neutralization with Lime - Lime is added to the typically acidic open hearth furnace process wastewaters to adjust the wastewater pH to the neutral range (6.0 to 9.0).	Lime addition for the purpose of pH control is employed in this subdivision and in many wastewater treatment applications in this industry and in other industries.	The lime feed and pH control systems require routine maintenance. Dissolved solids concentrations will be increased.	12 months	Refer to Table VIII-12	The solids which result from this step must receive proper disposal. Lime dusts must be exhausted from the workplace atmosphere.	The solids which are added and/or generated as a result of this step are removed in Step A. The solid waste generation values for this step are included in the values presented in Table VIII-14. This step's solid wastes will consist of lime solids, or fluoride or metallic precipitates.

TABLE VIII-9
CONTROL AND TREATMENT TECHNOLOGIES
OPEN HEARTH FURNACE SUBDIVISION
PAGE 2

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
D. Vacuum Filter - Used to dewater the sludges removed in Step A, thus reducing the mass and volume of solids requiring further handling or disposal. The filtrate is returned to the thickener.	Widely used in this subdivision and in other wastewater treatment applications in this industry and in other industries.	Routine maintenance of vacuum pumps and filter mechanical equipment is required. The filter media must be replaced periodically.	15 to 18 months	Refer to Table VIII-12	The dewatered solids must receive proper disposal.	Refer to the solid waste generation rates presented on Table VIII-14. The nature of the solids in the filter cake is the same as that of the solids removed in Step A.
E. Recycle - In the semi-wet treatment model, all of the thickener effluent is returned to the process. In the wet treatment model, a major portion of the thickener effluent is returned to the process.	Used widely in the subdivisions of this subcategory and in other subcategories in this industry. Treatment model recycle rates are defined by the treatment model applied and effluent flows, which in turn, are based on actual performance in each subdivision (refer to Sections IX and X).	The potential exists for scaling and plugging due to the increased dissolved solids concentrations associated with the recycle of process wastewaters.	12 to 14 months	Refer to Table VIII-12	None	None
F. Filtration - Used to provide additional suspended solids removal capability. Additional suspended solids removal will also provide additional removal of those pollutants (i.e., toxic metals) entrained in the suspended solids.	The capabilities of this technology are well demonstrated in other subcategories in this industry and in other industries.	Hydraulic overloads must be controlled. Poor backwashing will impede efficient filter operation.	15 to 18 months	Refer to Table VIII-12	The backwashed solids must eventually receive proper disposal.	Solid waste generation values for this step are included in the values presented in Table VIII-14. The nature of the backwash solids is the same as that of the solids removed via gravity sedimentation in the thickener.

TABLE VIII-9
CONTROL AND TREATMENT TECHNOLOGIES
OPEN HEARTH FURNACE SUBDIVISION
PAGE 3

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
G. Flocculation with Lime - Lime addition not only precipitates a portion of the fluoride waste load (as calcium fluoride), but also results in an additional reduction of the toxic metals load in the recycle system blowdown.	Lime flocculation is employed in wastewater treatment operations in this subdivision, in the other steelmaking subdivisions, in this industry, and in other industries.	Dissolved solids levels in the effluent will be increased.	12 months	Refer to Table VIII-12	Additional solids generated as a result of this step must receive proper disposal. Lime dusts must be exhausted from the workplace atmosphere.	Solid waste generation values for this step are included in the data presented in Table VIII-14. The solids generated as a result of incorporating this step would be removed in Step H. This step's solid wastes would consist of lime solids, calcium fluoride precipitates, and metallic hydroxide precipitates. As they settle, solids may also capture some of the process wastewater suspended particulate matter.
H. Inclined Plate Separator - This step provides for the gravity sedimentation of the suspended particulate matter added by and/or generated in Step G (flocculation with lime).	This technology is widely employed in this industry and in other industries.	Abrupt process upsets must be controlled. Sludge accumulation must be closely monitored to insure that adequate sludge withdrawal is maintained.	10 to 12 months	Refer to Table VIII-12	The solids generated and/or added in Step G, and then removed in this step, must receive proper disposal.	Solid waste generation values for this step are included in the values presented on Table VIII-14. The composition of the solid wastes removed in this step is described above in Step G.

TABLE VIII-9
CONTROL AND TREATMENT TECHNOLOGIES
OPEN HEARTH FURNACE SUBDIVISION
PAGE 4

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
I. Sulfide Precipitation - A sulfide source is added to the wastewater stream in order to form metallic sulfide precipitates which are subsequently removed via filtration (refer to Step F).	Used in a variety of industrial wastewater treatment applications for the purpose of providing additional toxic metals removal capabilities.	Care must be exercised in the handling and use of the feed solutions. Tight treatment process control is essential.	6 months	Refer to Table VIII-12	The resultant metal sulfide precipitates require proper disposal. Sulfide odors can result if adequate treatment process control is not provided.	Solid waste generation values for this treatment component are included in the values presented on Table VIII-14. The solid wastes generated in this step consist of the sulfide precipitates of iron and the toxic metals.

NOTE: Steps A through E are common to the semi-wet and wet treatment models.
Steps F through I apply to the wet segment treatment model only.

TABLE VIII-10

CONTROL AND TREATMENT TECHNOLOGIES ELECTRIC ARC FURNACE SUBDIVISION

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
A. Thickener - This component provides a substantial reduction (via gravity sedimentation) in the wastewater suspended solids load.	Very widely used in the various segments of this subdivision and in wastewater treatment applications in the other steelmaking subdivisions, in this industry, and in other industries.	Hydraulic surges must be controlled. Routine or continuous sludge removal must also be provided in order to prevent excessive solids accumulations which could damage the rake drive and hinder the removal of sludge.	15 to 18 months	Refer to Table VIII-13	The solids removed from the thickener and delivered to the vacuum filter must ultimately receive proper disposal, although these solids could be processed (pelletizing, etc.) for reuse.	Refer to Table VIII-14 for the solid waste generation rates for the various treatment models. These solids consist primarily of the various metal oxides (principally iron oxide) generated in the steelmaking process.
B. Coagulant Aid Addition - Coagulant aids (polymeric flocculants, etc.) are added to the process wastewater influent to the thickener to enhance the sedimentation of suspended particulate matter.	Widely used in this subdivision, in other subdivisions in this industry, and in other industries.	Dissolved solids levels may be increased.	6 months	Refer to Table VIII-13	Results in a minor increase in the quantities of solids which must subsequently receive proper disposal.	Solid waste generation rates for this step are included in the values presented on Table VIII-14. The solid waste constituents of this step are similar to the solid waste constituents of Step A.
C. Vacuum Filter - Used to dewater the sludges removed in Step A, thus reducing the mass and volume of solids requiring further handling or disposal. The filtrate is returned to the thickener.	Widely used in this subdivision and in other wastewater treatment applications in this industry and in other industries.	Routine maintenance of vacuum pumps and filter mechanical equipment is required. The filter media must be replaced periodically.	15 to 18 months	Refer to Table VIII-13	The dewatered solids must receive proper disposal.	Refer to the solid waste generation rates presented on Table VIII-14. The nature of the solids in the filter cake is the same as that of the solids removed in Step A.

TABLE VIII-10
CONTROL AND TREATMENT TECHNOLOGIES
ELECTRIC ARC FURNACE SUBDIVISION
PAGE 2

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
D. Recycle - In the semi-wet treatment model, all of the thickener effluent is returned to the process. In the wet segment treatment model a major portion of the thickener effluent is returned to the process.	Used widely in the segments of this subdivision and in other subdivision in this industry. Treatment model recycle rates are defined by the treatment model applied and effluent flows, which in turn, are based on actual performance in each subdivision (refer to Sections IX and X).	The potential exists for scaling and plugging due to the increased dissolved solids concentrations associated with the recycle of process wastewaters.	12 to 14 months	Refer to Table VIII-13	None	None
E. Filtration - Used to provide additional suspended solids removal capability. Additional suspended solids removal will also provide additional removal of those pollutants (i.e., toxic metals) entrained in the suspended solids.	The capabilities of this technology are well demonstrated in other subcategories in this industry and in other industries.	Hydraulic overloads must be controlled. Poor backwashing will impede efficient filter operation.	15 to 18 months	Refer to Table VIII-13	The backwashed solids must eventually receive proper disposal.	Solid waste generation values for this step are included in the values presented in Table VIII-14. The nature of the backwash solids is the same as that of the solids removed via gravity sedimentation in the thickener.

TABLE VIII-10
CONTROL AND TREATMENT TECHNOLOGIES
ELECTRIC ARC FURNACE SUBDIVISION
PAGE 3

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
F. Flocculation with Lime - Lime addition not only precipitates a portion of the fluoride waste load (as calcium fluoride), but also results in an additional reduction of the toxic metals load in the recycle system blowdown.	Lime flocculation is employed in wastewater treatment operations in this subdivision, in the other steelmaking subdivisions, in this industry, and in other industries.	Dissolved solids levels in the effluent will be increased.	12 months	Refer to Table VIII-13	Additional solids generated as a result of this step must receive proper disposal. Lime dusts must be exhausted from the workplace atmosphere.	Solid waste generation values for this step are included in the data presented in Table VIII-14. The solids generated as a result of incorporating this step would be removed in Step G. This step's solid wastes would consist of lime solids, calcium fluoride precipitates, and metallic hydroxide precipitates. As they settle, solids may also capture some of the process wastewater suspended particulate matter.
G. Inclined Plate Separator - This step provides for the gravity sedimentation of the suspended particulate matter added by and/or generated in Step F (flocculation with lime).	This technology is widely employed in this industry and in other industries.	Abrupt process upsets must be controlled. Sludge accumulation must be closely monitored to insure that adequate sludge withdrawal is being maintained.	10 to 12 months	Refer to Table VIII-13	The solids generated and/or added in Step F, and then removed in this step, must receive proper disposal.	Solid waste generation values for this step are included in the values presented on Table VIII-14. The composition of the solid wastes removed in this step is described above in Step F.

TABLE VIII-10
CONTROL AND TREATMENT TECHNOLOGIES
ELECTRIC ARC FURNACE SUBDIVISION
PAGE 4

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
H. Sulfide Precipitation - A sulfide source is added to the wastewater stream in order to form metallic sulfide precipitates which are subsequently removed via filtration (refer to Step E).	Used in a variety of industrial wastewater treatment applications for the purpose of providing additional toxic metals removal capabilities.	Care must be exercised in the handling and use of the feed solutions. Tight treatment process control is essential.	6 months	Refer to Table VIII-13	The resultant metal sulfide precipitates require proper disposal. Sulfide odors can result if adequate treatment process control is not provided.	Solid waste generation values for this treatment component are included in the values presented on Table VIII-14. The solid wastes generated in this step consist of the sulfide precipitates of iron and the toxic metals.

NOTE: Steps A through D are common to the semi-wet and wet treatment models.
Steps E through H apply to the wet treatment model only.

TABLE VIII-11

LAND REQUIREMENTS
BASIC OXYGEN FURNACE SUBDIVISION

BPT and BAT Treatment Models

	C&TT STEPS								
	A (T)	B (FLP)	C (VF)	D (RTP)	E (NA)	F (Filter)	G (FLL)	H (TP)	I (PS)
Semi-Wet	85'x85'	10'x10'	25'x25'	10'x15'	*	*	*	*	*
Wet- Suppressed Combustion	160'x160'	10'x20'	30'x55'	15'x25'	10'x15'	15'x20'	12'x12'	25'x25'	10'x10'
Wet- Open Combustion	130'x255'	20'x20'	50'x85'	15'x30'	15'x20'	25'x40'	12'x12'	35'x35'	10'x10'

---

*: These steps are not incorporated in this segment's treatment model.

NOTE: For a definition of the C&TT codes, refer to Table VII-1.

TABLE VIII-12

LAND REQUIREMENTS
OPEN HEARTH FURNACE SUBDIVISION

BPT and BAT Treatment Models

	C&TT STEPS								
	A (T)	B (FLP)	C (NL)	D (VF)	E (RTP)	F (Filter)	G (FLL)	H (TP)	I (PS)
Semi-Wet	160'x160'	10'x20'	30'x30'	45'x45'	15'x25'	*	*	*	*
Wet	150'x295'	20'x20'	30'x40'	40'x90'	20'x30'	30'x40'	20'x20'	30'x30'	15'x20'

---

*: These steps are not incorporated in this segment's treatment model.

NOTE: For a definition of the C&TT codes, refer to Table VII-1.

TABLE VIII-13

LAND REQUIREMENTS
ELECTRIC ARC FURNACE SUBDIVISION

BPT and BAT Treatment Models

	C&TT STEPS							
	A (T)	B (FLP)	C (VF)	D (RTP)	E (Filter)	F (FLL)	G (TP)	H (PS)
Semi-Wet	50'x50'	10'x10'	30'x30'	10'x10'	*	*	*	*
Wet	115'x115'	10'x12'	40'x75'	20'x20'	20'x25'	15'x15'	15'x15'	10'x10'

---

*: These steps are not incorporated in this segment's treatment model.

NOTE: For a definition of the C&TT codes, refer to Table VII-1.

TABLE VIII-14

SOLID WASTE GENERATION SUMMARY
BPT AND BAT TREATMENT LEVELS
STEELMAKING SUBCATEGORY

	BPT/BAT Feed			BAT Alternative No. 1(1)			BAT Alternative No. 2(1)			BAT Alternative No. 3(1)		
	Pounds Per Ton(2)	Tons Per Day(3)	Tons Per Year(4)	Pounds Per Ton(2)	Tons Per Day(3)	Tons Per Year(4)	Pounds Per Ton(2)	Tons Per Day(3)	Tons Per Year(4)	Pounds Per Ton(2)	Tons Per Day(3)	Tons Per Year(4)
Basic Oxygen Furnace												
Semi-Wet	0.982	2.60	9,490	*	*	*	*	*	*	*	*	*
Wet-Suppressed Combustion	12.11	44.81	98,130	0.015	0.056	118	0.059	0.218	482	0.015	0.056	121
Wet-Open Combustion	38.09	173.3	885,600	0.019	0.086	441	0.077	0.350	1,785	0.020	0.091	459
Open Hearth Furnace												
Semi-Wet	5.16	17.03	6,220	*	*	*	*	*	*	*	*	*
Wet	18.41	61.67	67,530	0.032	0.107	118	0.385	1.29	1,411	0.032	0.07	118
Electric Arc Furnace												
Semi-Wet	2.69	4.17	4,570	*	*	*	*	*	*	*	*	*
Wet	58.71	52.84	173,600	0.015	0.014	43	0.068	0.061	201	0.015	0.014	45

---

*: In these segments, the BPT level of treatment provides for the elimination of process wastewater pollutant discharges. Therefore, no BAT treatment models were developed.

(1) The BAT solid waste generation values are additional to the BPT/BAT Feed solid waste generation values.
(2) Pounds of solid waste per ton of production based on the treatment model.
(3) Tons of solid waste per day based on the treatment model.
(4) Model solid waste generation data expanded to reflect solid waste generation for all plants in each segment.

TABLE VIII-15

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory: Basic Oxygen Furnace
: Semi-Wet
: Carbon

Model Size-TPD : 5300
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	A(3)	B	C(3)	D	Total
Investment $\$ \times 10^{-3}$	724	32	332	374	1462
Annual Cost $\$ \times 10^{-3}$					
Capital	31.1	1.4	14.3	16.1	62.9
Depreciation	72.4	3.2	33.2	37.4	146.2
Operation and Maintenance	25.3	1.1	11.6	13.1	51.1
Sludge Disposal	-	-	15.5	-	15.5
Energy and Power(1)	1.6	1.1	5.9	9.8(2)	8.6
Chemical Costs	-	21.0	-	-	21.0
TOTAL	130.4	27.8	80.5	66.6(2)	305.3
Less Credit(4)			7.8		7.8
Net Total			72.7		297.5

Wastewater Parameters	Raw Waste Load	BPT Effluent Level
Flow, gal/ton	360	0
pH, Units	10-12	-
Concentrations, mg/l		
Suspended Solids	375	-
Fluoride	10	-
120 Copper	0.040	-
122 Lead	1.5	-
123 Mercury	0.003	-
128 Zinc	1.0	-

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 100%

TABLE VIII-16

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory:	Basic Oxygen Furnace (Wet)	Model Size-TPD :	7400
:	Suppressed Combustion	Oper. Days/Year:	365
:	Carbon and Specialty	Turns/Day :	3

C&TT Step	A(3)	B	C(3)	D	E	Total
Investment \$ x 10^{-3}	1772	35	559	756	48	3170
Annual Cost \$ x 10^{-3}						
Capital	76.2	1.5	24.0	32.5	2.0	136.2
Depreciation	177.2	3.5	55.9	75.6	4.8	317.0
Operation and Maintenance	62.0	1.2	19.6	26.5	1.7	111.0
Sludge Disposal	-	-	337.6	-	-	337.6
Energy and Power(1)	5.7	0.7	19.1	40.8(2)	0.7	26.2
Chemical Costs	-	81.5	-	-	3.0	84.5
TOTAL	321.1	88.4	456.2	134.6(2)	12.2	1012.5
Less Credit(4)			581.4			581.4
Net Total			-125.2			431.1

Wastewater Parameters		Raw Waste Load	BPT Effluent Level
	Flow, gal/ton	1000	50
	pH, Units	8-11	6-9
Concentrations, mg/l			
	Suspended Solids	1500	50
	Fluoride	15	15
118	Cadmium	0.10	0.10
119	Chromium	0.50	0.10
120	Copper	0.25	0.15
122	Lead	15.00	3.50
124	Nickel	0.50	0.25
126	Silver	0.025	0.25
128	Zinc	5.00	1.00

---

(1) Costs are all power unless otherwise noted.

(2) Total does not include power cost, as a credit is supplied for existing process water requirements.

(3) Treatment components are used in tandem.

(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 95%
E: pH Adjustment with Acid

TABLE VIII-17

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory:	Basic Oxygen Furnace (Wet)	Model Size-TPD :	9100
:	Open Combustion	Oper. Days/Year:	365
:	Carbon and Specialty	Turns/Day :	3

C&TT Step	A(3)	B	C(3)	D	E	Total
Investment $\$ \times 10^{-3}$	2557	66	1651	743	200	5217
Annual Cost $\$ \times 10^{-3}$						
Capital	109.9	2.8	71.0	32.0	8.6	224.3
Depreciation	255.7	6.6	165.1	74.3	20.0	521.7
Operation and Maintenance	89.5	2.3	57.8	26.0	7.0	182.6
Sludge Disposal	-	-	1277.5	-	-	1277.5
Energy and Power(1)	8.2	1.3	112.4	40.8(2)	1.8	123.7
Chemical Costs	-	109.7	-	-	11.0	120.7
TOTAL	463.3	122.7	1683.8	132.3(2)	48.4	2450.5
Less Credit(4)			1090.0			1090.0
Net Total			593.8			1360.5

	Wastewater Parameters	Raw Waste Load	BPT Effluent Level
	Flow, gal/ton	1100	50
	pH, Units	8-11	6-9
	Concentrations, mg/l		
	Suspended Solids	4200	50
	Fluoride	15	15
23	Chloroform	0.05	0.05
115	Arsenic	0.05	0.05
118	Cadmium	0.50	0.30
119	Chromium	5.00	1.00
120	Copper	0.50	0.25
122	Lead	1.00	0.50
123	Mercury	0.01	0.01
124	Nickel	0.50	0.30
125	Selenium	0.025	0.025
126	Silver	0.20	0.15
127	Thallium	0.10	0.10
128	Zinc	5.00	1.00

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 95%
E: pH Adjustment with Acid

TABLE VIII-18

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory:	Open Hearth Furnace	Model Size-TPD :	6600
:	Semi-Wet	Oper. Days/Year:	365
:	Carbon	Turns/Day :	3

C&TT Step	A(3)	B	C(3)	D	E	Total
Investment \$ x 10^{-3}	1838	34	244	586	797	3499
Annual Cost \$ x 10^{-3}						
Capital	79.0	1.5	10.5	25.2	34.3	150.5
Depreciation	183.8	3.4	24.4	58.6	79.7	349.9
Operation and Maintenance	64.3	1.2	8.6	20.5	27.9	122.5
Sludge Disposal	-	-	-	124.1	-	124.1
Energy and Power(1)	3.3	0.7	9.5	18.8	32.7(2)	32.3
Chemical Costs	-	80.2	38.7	-	-	118.9
TOTAL	330.4	87.0	91.7	247.2	141.9(2)	898.2
Less Credit(4)				49.6		49.6
Net Total				197.6		848.6

	Wastewater Parameters	Raw Waste Load	BPT Effluent Level
	Flow, gal/ton	1100	0
	pH, Units	2-3	-
	Concentrations, mg/l		
	Suspended Solids	500	-
	Fluoride	260	-
121	Cyanide	0.04	-
119	Chromium	0.08	-
120	Copper	0.08	-
124	Nickel	0.05	-
128	Zinc	0.60	-

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Neutralization with Lime
D: Vacuum Filter
E: Recycle 100%

TABLE VIII-19

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory: Open Hearth Furnace
: Wet
: Carbon and Specialty

Model Size-TPD : 6700
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	A(3)	B	C(3)	D	E	Total
Investment $\$ \times 10^{-3}$	3030	76	444	1020	945	5515
Annual Cost $\$ \times 10^{-3}$						
Capital	130.3	3.3	19.1	43.9	40.6	237.2
Depreciation	303.0	7.6	44.4	102.0	94.5	551.5
Operation and Maintenance	106.0	2.7	15.5	35.7	33.1	193.0
Sludge Disposal	-	-	-	270.1	-	270.1
Energy and Power(1)	6.5	1.0	17.6	38.4	65.3(2)	63.5
Chemical Costs	-	139.3	67.9	-	-	207.2
TOTAL	545.8	153.9	164.5	490.1	168.2(2)	1522.5
Less Credit(4)				251.9		251.9
Net Total				238.2		1270.6

	Wastewater Parameters	Raw Waste Load	BPT Effluent Level
	Flow, gal/ton	1900	110
	pH, Units	3-7	6-9
	Concentrations, mg/l		
	Suspended Solids	1100	50
	Fluoride	110	100
120	Copper	2.00	0.25
122	Lead	0.60	0.50
128	Zinc	200	5.00

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Neutralization with Lime
D: Vacuum Filter
E: Recycle 94%

TABLE VIII-20

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory:	Electric Arc Furnace	Model Size-TPD :	3100
:	Semi-Wet	Oper. Days/Year:	365
:	Carbon	Turns/Day :	3

C&TT Step	A(3)	B	C(3)	D	Total
Investment \$ x 10^{-3}	384	36	283	267	970
Annual Cost \$ x 10^{-3}					
Capital	16.5	1.6	12.2	11.5	41.8
Depreciation	38.4	3.6	28.3	26.7	97.0
Operation and Maintenance	13.4	1.3	9.9	9.3	33.9
Sludge Disposal	-	-	31.0	-	31.0
Energy and Power(1)	1.6	0.7	7.3	3.3(2)	9.6
Chemical Costs	-	5.1	-	-	5.1
TOTAL	69.9	12.3	88.7	47.5(2)	218.4
Less Credit(4)			7.3		7.3
Net Total			81.4		211.1

	Wastewater Parameters	Raw Waste Load	BPT Effluent Level
	Flow, gal/ton	150	0
	pH, Units	6-9	-
	Concentrations, mg/l		
	Suspended Solids	2200	-
	Fluoride	30	-
120	Copper	2	-
122	Lead	30	-
128	Zinc	125	-

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 100%

TABLE VIII-21

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory:	Electric Furnace	Model Size-TPD :	1800
:	Wet	Oper. Days/Year:	365
:	Carbon and Specialty	Turns/Day :	3

C&TT Step	A(3)	B	C(3)	D	Total
Investment \$ x 10^{-3}	1189	55	911	534	2689
Annual Cost \$ x 10^{-3}					
Capital	51.1	2.3	39.2	23.0	115.6
Depreciation	118.9	5.5	91.1	53.4	268.9
Operation and Maintenance	41.6	1.9	31.9	18.7	94.1
Sludge Disposal	-	-	385.7	-	385.7
Energy and Power(1)	4.1	1.0	35.7	20.4(2)	40.8
Chemical Costs	-	41.4	-	-	41.4
TOTAL	215.7	52.1	583.6	95.1(2)	946.5
Less Credit(4)			21.3		21.3
Net Total			562.3		925.2

	Wastewater Parameters	Raw Waste Load	BPT Effluent Level
	Flow, gal/ton	2100	50
	pH, Units	6-9	6-9
	Concentrations, mg/l		
	Suspended Solids	3400	50
	Fluoride	50	50
4	Benzene	0.015	0.015
39	Fluoranthene	0.020	0.020
58	4-Nitrophenol	0.015	0.015
64	Pentachlorophenol	0.015	0.015
84	Pyrene	0.020	0.020
114	Antimony	0.70	0.10
115	Arsenic	2.0	0.10
118	Cadmium	4.0	2.0
119	Chromium	5.0	0.50
120	Copper	2.0	0.25
122	Lead	30.0	2.5
124	Nickel	0.05	0.05
126	Silver	0.06	0.06
128	Zinc	125	30

---

(1) Costs are all power unless otherwise noted.

(2) Total does not include power cost, as a credit is supplied for existing process water requirements.

(3) Treatment components are used in tandem.

(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 98

TABLE VIII-22

BPT CAPITAL COST TABULATION

Subdivision: Basic Oxygen Furnace (Semi-Wet)
: Carbon Facilities

Basis: 7/1/78 Dollars X 10^{-3}
: Facilities In Place as of 1/1/78

Plant Code	TPD	C&TT Step A	B	C	D	In Place	Required	Total
0396D	2400	450	20	206	233	909	0	909
0432A	9600	1034	46	-	534	1614	0	1,614
0432C	6585	824	37	378	426	1239	426	1,665
0584C	6900	848	38	389	438	848	865	1,713
0684B	7120	432-432	39	396	447	471	1275	1,746
0684G	4536	659	30	-	341	659	371	1,030
0684I	4500	656	29	-	339	656	368	1,024
0920B	4800	682	-	-	-	682	0	682
0946A	3480	281-281	25	258	274-17	813	323	1,136
						7891*	3628*	11,519*

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*: Totals do not include confidential plants

NOTE: Underlined costs represent facilities in place. Where two figures appear in the same column, the underlined portion is in place; the non-underlined portion remains to be installed.

Legend

A: Classifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 100%

TABLE VIII-23

BPT CAPITAL COST TABULATION

Subdivision: Basic Oxygen Furnace (Wet)
: Suppressed Combustion
: Carbon

Basis: 7/1/78 Dollars X 10^{-3}
: Facilities In Place as of 1/1/78

Plant Code	TPD	C&TT Step A	B	C	D	E	In Place	Required	Total
0060	7599	1801	35	568	740-28	48	3,144	76	3,220
0384A	6000	1563	31	493	649-18	42	2,212	584	2,796
0528A	6000	1563	31	493	667	42	1,563	1233	2,796
0684F	9800	2098	41	662	895	56	3,752	0	3,752
0684H	7168	1739	34	549	742	47	3,064	47	3,111
0856N	7700	1815	35	573	775	49	2,625	622	3,247
							16,360	2562	18,922

NOTE: Underlined costs represent facilities in place. Where two figures appear in the same column, the underlined portion is in place; the non-underlined portion remains to be installed.

Legend

A: Classifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 95%
E: pH Adjustment with Acid

TABLE VIII-24

BPT CAPITAL COST TABULATION

Subdivision: Basic Oxygen Furnace (Wet)
: Open Combustion
: Carbon

Basis: 7/1/78 Dollars X 10^{-3}
: Facilities In Place as of 1/1/78

Plant Code	TPD	C&TT Step A	B	C	D	E	In Place	Required	Total
0112A	9,167	2568	66	1659	680-66	201	3,314	1,926	5,240
0112B	14,400	3367	86	2175	979	263	5,542	1,328	6,870
0112D	12,050	3026	78	1954	879	237	6,174	0	6,174
0248A	2,400	1149	29	742	334	90	2,010	334	2,344
0384A	11,200	2896	74	1871	797-45	227	3,693	2,217	5,910
0584F	11,690	2971	76	1919	864	232	5,830	232	6,062
0724A	3,500	1441	37	931	352-67	113	2,761	180	2,941
0856B	7,750	2322	59	1500	675	182	3,822	916	4,738
0856R	7,500	2276	58	1470	662	178	3,746	898	4,644
0860B*	27,400	6530	168	4216	1713-185	511	12,459	864	13,323
0860H	11,200	2896	74	1871	52-790	227	5,120	790	5,910
0868A	7,440	2264	58	1462	658	177	4,442	177	4,619
0920N	8,550	2463	63	1591	716	193	4,054	972	5,026
						**	62,967	10,834	73,801

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* : Includes two shops
**: Totals do not include confidential plants

NOTE: Underlined costs represent facilities in place. Where two figures appear in the same column, the underlined portion is in place; the non-underlined portion remains to be installed.

Legend

A: Classifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 95%
E: pH Adjustment with Acid

TABLE VIII-25

BPT CAPITAL COST TABULATION

Subdivision: Open Hearth Furnace (Semi-Wet) Basis: 7/1/78 Dollars x 10^{-3}
: Carbon Facilities : Facilities In Place as of 1/1/78

		C&TT Step							
Plant Code	TPD	A	B	C	D	E	In Place	Required	Total
0864A	6600	1838	34	244	586	747-50	2863	636	3499
							2863	636	3499

NOTE: Underlined costs represent facilities in place. Where two figures appear in the same column, the underlined portion is in place; the non-underlined portion remains to be installed.

Legend

A: Classifier/Thickener
B: Coagulant Aid Addition
C: pH Adjustment with Lime
D: Vacuum Filter
E: Recycle 100%

TABLE VIII-26

BPT CAPITAL COST TABULATION

Subdivision: Open Hearth Furnace
: Wet
: Carbon

Basis: 7/1/78 Dollars X 10^{-3}
: Facilities In Place as of 1/1/78

Plant Code	TPD	C&TT Step A	B	C	D	E	In Place	Required	Total
0060	5,507	2,693	68	395	907	840	4,903	0	4,903
0112A	10,822	4,093	102	592	1,360	1260	5,401	1,952	7,353
0492A	3,835	2,167	55	318	730	245-431	3,515	431	3,946
							13,819	2,383	16,202

NOTE: Underlined costs represent facilities in place. Where two figures appear in the same column, the underlined portion is in place; the non-underlined portion remains to be installed.

Legend

A: Classifier/Thickener
B: Coagulant Aid Addition
C: pH Adjustment with Lime
D: Vacuum Filters
E: Recycle 94%

TABLE VIII-27

BPT CAPITAL COST TABULATION

Subdivision: Electric Arc Furnace
: Semi-Wet
: Carbon

Basis: 7/1/78 Dollars X 10^{-3}
: Facilities In Place as of 1/1/78

Plant Code	TPD	C&TT Step A	C&TT Step B	C&TT Step C	C&TT Step D	In Place	Required	Total
0060F	3900	440	41	324	306	764	347	1111
0432C	2280	319	30	235	222	584	222	806
0584A	1903	NA	NA	-	-	0	0	0
						1348	569	1917

Legend

A: Classifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 100%

TABLE VIII-28

BPT CAPITAL COST TABULATION

Subdivision: Electric Arc Furnace
: Wet
: Carbon

Basis: 7/1/78 Dollars X 10^{-3}
: Facilities In Place as of 1/1/78

Plant Code	TPD	C&TT Step A	B	C	D	In Place	Required	Total
0060F	1100	885	41	678	364-33	1,927	74	2,001
0492A	900	784	36	601	106-246	1,527	246	1,773
0528A	1400	1022	47	783	459	1,852	459	2,311
0612	5500	2323	107	1781	1044	5,148	107	5,255
0856F	1600	1108	51	849	483-15	1,591	915	2,506
0860H*	2448	1430	66	1096	315-327	2,841	393	3,234
0868B	1560	1091	50	836	450-40	2,377	90	2,467
						17,263	2284	19,547

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*: This plant has two EAF shops. The process wastewaters are co-treated.

TABLE VIII-28
BPT CAPITAL COST TABULATION
PAGE 2

Subcategory: Electric Arc Furnace
: Wet
: Specialty

		C&TT Step						
Plant Code	TPD	A	B	C	D	In Place	Required	Total
0060D	2564	1470	67	1126	506-154	3102	221	3323
						3102	221	3323

NOTE: Underlined costs represent facilities in place. Where two figures appear in the same column, the underlined portion is in place; the non-underlined portion remains to be installed.

Legend

A - Classifier/Thickener
B - Coagulant Aid Addition
C - Vacuum Filter
D - Recycle 98%

TABLE VIII-29

ALTERNATIVE BAT MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Basic Oxygen Furnace-Wet
: Suppressed Combustion
: Carbon and Specialty

Model Size-TPD : 7400
Oper. Days/Year: 365
Turns/Day : 3

Alternative C&TT Steps	BAT No. 1 F	BAT No. 1 Total	BAT No. 2 F &	BAT No. 2 G	BAT No. 2 H	BAT No. 2 Total	BAT No. 3 F &	BAT No. 3 I	BAT No. 3 Total
Investment \$ x 10^{-3}	108	108		95	220	423		63	171
Annual Cost \$ x 10^{-3}									
Capital	4.7	4.7		4.1	9.5	18.3		2.7	7.4
Depreciation	10.8	10.8		9.5	22.0	42.3		6.3	17.1
Operation & Maintenance	3.8	3.8		3.3	7.7	14.8		2.2	6.0
Energy and Power(1)	1.6	1.6		1.5	0.8	3.9		0.8	2.4
Chemical Costs	-	-		2.0	-	2.0		2.3	2.3
TOTAL	20.9	20.9		20.4	40.0	81.3		14.3	35.2

Wastewater Parameters	BAT Feed Level	BAT No.1 Effluent Level	BAT No.2 Effluent Level	BAT No.3 Effluent Level
Flow, gal/ton	50	50	50	50
pH (Units)	6-9	6-9	6-9	6-9
Concentrations, mg/l				
Suspended Solids	50	15	15	15
Fluoride	15	15	10	15
118 Cadmium	0.10	0.10	0.10	0.10
119 Chromium	0.10	0.10	0.10	0.10
120 Copper	0.15	0.15	0.10	0.10
122 Lead	3.50	2.00	0.30	0.15
124 Nickel	0.25	0.25	0.10	0.10
126 Silver	0.025	0.025	0.025	0.025
128 Zinc	1.00	0.90	0.30	0.25

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(1) Costs are all power unless otherwise noted.

KEY TO C&TT STEPS

F: Filtration
G: Lime Addition
H: Clarifier (Tube Plate Settler)
I: Sulfide Precipitation

TABLE VIII-30

ALTERNATIVE BAT MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory:	Basic Oxygen Furnace-Wet	Model Size-TPD :	9100
:	Open Combustion	Oper. Days/Year:	365
:	Carbon and Specialty	Turns/Day :	3

Alternative C&TT Steps	BAT No. 1		BAT No. 2				BAT No. 3		
	F	Total	F &	G	H	Total	F &	I	Total
Investment $ x 10^{-3}	252	252		90	236	578		84	336
Annual Cost $ x 10^{-3}									
Capital	10.8	10.8		3.9	10.1	24.8		3.6	14.4
Depreciation	25.2	25.2		9.0	23.6	57.8		8.4	33.6
Operation and Maintenance	8.8	8.8		3.2	8.3	20.3		2.9	11.7
Energy and Power(1)	4.1	4.1		2.4	1.2	7.7		1.2	5.3
Chemical Costs	-	-		3.2	-	3.2		3.7	3.7
TOTAL	48.9	48.9		21.7	43.2	113.8		19.8	68.7

Wastewater Parameter	BAT Feed Level	BAT No. 1 Effluent Level	BAT No. 2 Effluent Level	BAT No. Effluen Level
Flow, gal/ton	65	65	65	65
pH	6-9	6-9	6-9	6-9
Concentrations, mg/l				
Suspended Solids	50	15	15	15
Fluoride	15	15	10	15
23 Chloroform	0.05	0.05	0.05	0.05
115 Arsenic	0.05	0.05	0.05	0.05
118 Cadmium	0.30	0.30	0.10	0.10
119 Chromium	1.00	0.80	0.25	0.10
120 Copper	0.25	0.15	0.10	0.10
122 Lead	0.50	0.30	0.25	0.15
123 Mercury	0.01	0.005	0.005	0.005
124 Nickel	0.30	0.30	0.10	0.10
125 Selenium	0.025	0.025	0.025	0.025
126 Silver	0.15	0.15	0.15	0.15
127 Thallium	0.10	0.10	0.10	0.10
128 Zinc	1.00	0.90	0.30	0.25

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(1) Costs are all power unless otherwise noted.

KEY TO C&TT STEPS

F: Filtration	H: Clarifier (Tube Plate Settler)
G: Lime Addition	I: Sulfide Precipitation

TABLE VIII-31

ALTERNATIVE BAT MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory:	Open Hearth Furnace	Model Size-TPD :	6700
:	Wet	Oper. Days/Year:	365
:	Carbon and Specialty	Turns/Day :	3

Alternative C&TT Steps	BAT No. 1 F	BAT No. 1 Total	BAT No. 2 F & G	BAT No. 2 H	BAT No. 2 Total	BAT No. 3 F & I	BAT No. 3 Total
Investment $ x 10^{-3}	287	287	269	231	787	96	383
Annual Cost $ x 10^{-3}							
Capital	12.4	12.4	11.6	9.9	33.9	4.1	16.5
Depreciation	28.7	28.7	26.9	23.1	78.7	9.6	38.3
Operation & Maintenance	10.1	10.1	9.4	8.1	27.6	3.3	13.4
Sludge Disposal	-	-	-	29.1	29.1	-	-
Energy and Power(1)	4.9	4.9	2.5	0.5	7.9	1.6	6.5
Chemical Costs	-	-	203.6	-	203.6	4.6	4.6
TOTAL	56.1	56.1	254.0	70.7	380.8	23.2	79.3

Wastewater Parameters	BAT Feed Level	BAT No.1 Effluent Level	BAT No.2 Effluent Level	BAT No.3 Effluent Level
Flow, gal/ton	110	110	110	110
pH (Units)	6-9	6-9	6-9	6-9
Concentrations, mg/l				
Suspended Solids	50	15	15	15
Fluoride	100	100	20	100
120 Copper	0.25	0.15	0.10	0.10
122 Lead	0.50	0.25	0.15	0.15
128 Zinc	5.00	4.50	0.30	0.25

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(1) Costs are all power unless otherwise noted.

KEY TO C&TT STEPS

F: Filtration
G: Lime Addition
H: Clarifier (Tube Plate Settler)
I: Sulfide Precipitation

TABLE VIII-32

ALTERNATIVE BAT MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Electric Furnace
: Wet
: Carbon and Specialty

Model Size-TPD : 1800
Oper. Days/Year: 365
Turns/Day : 3

Alternative	BAT No. 1		BAT No. 2				BAT No. 3		
C&TT Steps	E	Total	E &	F	G	Total	E &	H	Total
Investment $ x 10^{-3}	102	102		45	92	239		24	126
Annual Cost $ x 10^{-3}									
Capital	4.4	4.4		1.9	4.0	10.3		1.0	5.4
Depreciation	10.2	10.2		4.5	9.2	23.9		2.4	12.6
Operation & Maintenance	3.6	3.6		1.6	3.2	8.4		0.9	4.5
Energy and Power(1)	0.5	0.5		0.7	0.6	1.8		0.3	0.8
Chemical Costs	-	-		0.5	-	0.5		0.6	0.6
TOTAL	18.7	18.7		9.2	17.0	44.9		5.2	23.9

	Wastewater Parameters	BAT Feed Level	BAT No.1 Effluent Level	BAT No.2 Effluent Level	BAT No.3 Effluent Level
	Flow, gal/ton	50	50	50	50
	pH (Units)	6-9	6-9	6-9	6-9
	Concentrations, mg/l				
	Suspended Solids	50	15	15	15
	Fluoride	50	50	20	50
4	Benzene	0.015	0.015	0.015	0.015
39	Fluoranthene	0.020	0.020	0.020	0.020
58	4-Nitrophenol	0.015	0.015	0.015	0.015
64	Pentachlorophenol	0.015	0.015	0.015	0.015
84	Pyrene	0.020	0.020	0.020	0.020
114	Antimony	0.10	0.10	0.10	0.10
115	Arsenic	0.10	0.10	0.10	0.10
118	Cadmium	2.0	1.9	0.10	0.10
119	Chromium	0.50	0.40	0.15	0.10
120	Copper	0.25	0.15	0.10	0.10
122	Lead	2.50	1.50	0.30	0.15
124	Nickel	0.05	0.05	0.05	0.05
126	Silver	0.06	0.06	0.06	0.06
128	Zinc	30	25	0.35	0.25

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(1) Costs are all power unless otherwise noted.

KEY TO C&TT STEPS

E: Filtration
F: Lime Addition
G: Clarifier (Tube Plate Settler)
H: Sulfide Precipitation

TABLE VIII-33

INVESTMENT AND ANNUAL COSTS OF BAT STEELMAKING SUBCATEGORY

Steelmaking Subdivision	BAT No. 1		BAT No. 2		BAT No. 3	
	Investment Costs	Annual Costs	Investment Costs	Annual Costs	Investment Costs	Annual Costs
Basic Oxygen Furnace						
Wet-Suppressed Combustion	648,000	125,000	2,538,000	488,000	1,026,000	211,000
Basic Oxygen Furnace						
Wet-Open Combustion	3,528,000	685,000	8,092,000	1,593,000	4,704,000	962,000
Open Hearth						
Wet	861,000	168,000	2,361,000	1,142,000	1,149,000	238,000
Electric Arc Furnace						
Wet	918,000	168,000	2,151,000	404,000	1,134,000	215,000

TABLE VIII-34

RESULTS OF BCT COST TEST
BASIC OXYGEN FURNACE - WET-SUPPRESSED COMBUSTION

A. BCT Feed

Effluent Concentration of Conventional Pollutants = 50 mg/l
Flow = 0.37 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 56,316

B. BCT-1

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.37 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 16,895

lbs/Year of Conventional Pollutants Removed via Treatment
56,316 - 16,895 = 39,421
Annual Cost of BCT-1 = $20,900 $/lb = 0.53 PASS

C. BCT-2

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.37 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 16,895

lbs/Year of Conventional Pollutants Removed via Treatment
56,316 - 16,895 = 39,421
Annual Cost of BCT-2 = $60,900* $/lb = 1.54 FAIL
* Includes all of the C&TT Steps except lime addition.

TABLE VIII-35

RESULTS OF BCT COST TEST
BASIC OXYGEN FURNACE - WET-OPEN COMBUSTION

A. BCT Feed

Effluent Concentration of Conventional Pollutants = 50 mg/l
Flow = 0.46 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 69,253

B. BCT-1

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.59 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 27,009

lbs/Year of Conventional Pollutants Removed via Treatment
69,253 - 27,009 = 42,244
Annual Cost of BCT-1 = $48,900 $/lb = 1.16 PASS

C. BCT-2

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.59 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 27,009

lbs/Year of Conventional Pollutants Removed via Treatment
69, 253 - 27,009 = 42,244
Annual Cost of BCT-2 = $92,100* $/lb = 2.18 FAIL
* Includes all of the C&TT Steps except lime addition.

TABLE VIII-36

RESULTS OF BCT COST TEST
OPEN HEARTH FURNACE - WET

A. BCT Feed

Effluent Concentration of Conventional Pollutants = 50 mg/l
Flow = 0.737 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 112,175

B. BCT-1

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.737 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 33,653

lbs/Year of Conventional Pollutants Removed via Treatment
112,175 - 33,653 = 78,522
Annual Cost of BCT-1 = $56,100 $/lb = 0.71 PASS

C. BCT-2

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.737 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 33,653

lbs/Year of Conventional Pollutants Removed via Treatment
112,175 - 33,653 = 78,552
Annual Cost of BCT-2 = $126,800* $/lb = 1.61 FAIL
* Includes all of the C&TT Steps except lime addition.

TABLE VIII-37

RESULTS OF BCT COST TEST
ELECTRIC ARC FURNACE - WET

A. BCT Feed

Effluent Concentration of Conventional Pollutants = 50 mg/1
Flow = 0.09 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 13,698

B. BCT-1

Effluent Concentration of Conventional Pollutants = 15 mg/1
Flow = 0.09 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 4,110

lbs/Year of Conventional Pollutants Removed via Treatment
13,698 - 4,110 = 9,588
Annual Cost of BCT-1 = $18,700 $/lb = 1.95 FAIL

C. BCT-2

Effluent Concentration of Conventional Pollutants = 15 mg/1
Flow = 0.09 MGD
Days/Year = 365
lbs/Year of Conventional Pollutants Discharged = 4,110

lbs/Year of Conventional Pollutants Removed via Treatment
13,698 - 4,110 = 9,588
Annual Cost of BCT-2 = $35,700* $/lb = 3.72 FAIL
* Includes all of the C&TT Steps except lime addition.

TABLE VIII-38

NSPS MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory : Basic Oxygen Furnace
: Semi-Wet
: Carbon

Model Size-TPD : 5300
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	A(3)	B	C(3)	D	Total
Investment $\$ \times 10^{-3}$	724	32	332	374	1462
Annual Cost $\$ \times 10^{-3}$					
Capital	31.1	1.4	14.3	16.1	62.9
Depreciation	72.4	3.2	33.2	37.4	146.2
Operation and Maintenance	25.3	1.1	11.6	13.1	51.1
Sludge Disposal	-	-	15.5	-	15.5
Energy and Power(1)	1.6	1.1	5.9	9.8(2)	8.6
Chemical Costs	-	21.0	-	-	21.0
TOTAL	130.4	27.8	80.5	66.6(2)	305.3
Less Credit(4)			7.8		7.8
Net Total			72.7		297.5

Wastewater Parameters		Raw Waste Load	NSPS Effluent Level
	Flow, gal/ton	360	0
	pH (Units)	10-12	-
Concentrations, mg/l			
	Suspended Solids	375	-
	Fluoride	10	-
120	Copper	0.04	-
122	Lead	1.50	-
123	Mercury	0.003	-
128	Zinc	1.00	-

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(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 100%

TABLE VIII-39

NSPS MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory:	Electric Arc Furnace	Model Size-TPD :	3100
:	Semi-Wet	Oper. Days/Year:	365
:	Carbon and Specialty	Turns/Day :	3

C&TT Step	A(3)	B	C(3)	D	Total
Investment \$ x 10^{-3}	384	36	283	267	970
Annual Cost \$ x 10^{-3}					
Capital	16.5	1.6	12.2	11.5	41.8
Depreciation	38.4	3.6	28.3	26.7	97.0
Operation and Maintenance	13.4	1.3	9.9	9.3	33.9
Sludge Disposal	-	-	31.0	-	31.0
Energy and Power(1)	1.6	0.7	7.3	3.3(2)	9.6
Chemical Costs	-	5.1	-	-	5.1
TOTAL	69.9	12.3	88.7	47.5(2)	218.4
Less Credit(4)			7.3		7.3
Net Total			81.4		211.1

Wastewater Parameters	Raw Waste Load	NSPS Effluent Level
Flow, gal/ton	150	0
pH (Units)	6-9	-
Concentrations, mg/l		
Suspended Solids	2200	-
Fluoride	30	-
120 Copper	2	-
122 Lead	30	-
128 Zinc	125	-

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(1) Costs are all power unless otherwise noted.

(2) Total does not include power cost as a credit is supplied for existing process water requirements.

(3) Treatment components are used in tandem.

(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 100%

TABLE VIII-40

NSPS, PSES, AND PSNS MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Basic Oxygen Furnace - Wet
: Suppressed Combustion
: Carbon and Specialty

Model Size : 7400
Oper.Days/Year: 365
Turns/Day : 3

	NSPS Alternative No. 1							NSPS Alt. No. 2, PSES, AND PSNS				NSPS Alternative No. 3		
C&TT Step	A(3)	B	C(3)	D	E	F	Total	A-F	G	H	Total	A-F	I	Total
Investment $ x 10^{-3}	1772	35	559	756	108	48	3278		95	220	3593		63	3341
Annual Cost $ x 10^{-3}														
Capital	76.2	1.5	24.0	32.5	4.7	2.0	140.9		4.1	9.5	154.5		2.7	143.6
Depreciation	177.2	3.5	55.9	75.6	10.8	4.8	327.8		9.5	22.0	359.3		6.3	334.1
Operation & Maintenance	62.0	1.2	19.6	26.5	3.8	1.7	114.8		3.3	7.7	125.8		2.2	117.0
Sludge Disposal	-	-	337.6	-	-	-	337.6		-	-	337.6		-	337.6
Energy & Power(1)	5.7	0.7	19.1	40.8(2)	1.6	0.7	27.8		1.5	0.8	30.1		0.8	28.6
Chemical Costs	-	81.5	-	-	-	3.0	84.5		2.0	-	86.5		2.3	86.8
TOTAL	321.1	88.4	456.2	134.6(2)	20.9	12.2	1033.4		20.4	40.0	1093.8		14.3	1047.7
Less Credit(4)			581.4				581.4				581.4			581.4
Net Total			-125.2				452.0				512.4			466.3

Wastewater Parameters	Raw Waste Load	NSPS No.1 Effluent Level	NSPS No. 2, PSES, and PSNS Effluent Level	NSPS No. 3 Effluent Level
Flow, gal/ton	1000	50	50	50
pH	8-11	6-9	6-9	6-9
Concentrations, mg/l				
Suspended Solids	1500	15	15	15
Fluoride	15	15	10	15
118 Cadmium	0.10	0.10	0.10	0.10
119 Chromium	0.50	0.10	0.10	0.10
120 Copper	0.25	0.15	0.10	0.10
122 Lead	15.0	2.00	0.30	0.15
124 Nickel	0.50	0.25	0.10	0.10
126 Silver	0.025	0.025	0.025	0.025
128 Zinc	5.00	0.90	0.30	0.25

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(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter

D. Recycle 95%
E: Filtration
F: pH Adjustment with Acid

G: Lime Addition
H: Clarifier (Tube Plate Settler)
I: Sulfide Precipitation

TABLE VIII-41

NSPS, PSES, AND PSNS MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Basic Oxygen Furnace - Wet
: Open Combustion
: Carbon and Specialty

Model Size : 9100
Oper.Days/Year: 365
Turns/Day : 3

	NSPS Alternative No. 1							NSPS Alternative No. 2, PSES, and PSNS				NSPS Alternative No. 3		
C&TT Step	A(3)	B	C(3)	D	E	F	Total	A-F	G	H	Total	A-F	I	Total
Investment $ x 10^{-3}	2557	66	1651	743	252	200	5469		90	236	5795		84	5553
Annual Cost $ x 10^{-3}														
Capital	109.9	2.8	71.0	32.0	10.8	8.6	235.1		3.9	10.1	249.1		3.6	238.7
Depreciation	255.7	6.6	165.1	74.3	25.2	20.0	546.9		9.0	23.6	579.5		8.4	555.3
Operation & Maintenance	89.5	2.3	57.8	26.0	8.8	7.0	191.4		3.2	8.3	202.9		2.9	194.3
Sludge Disposal	-	-	1277.5	-	-	-	1277.5		-	-	1277.5		-	1277.5
Energy & Power(1)	8.2	1.3	112.4	40.8(2)	4.1	1.8	127.8		2.4	1.2	131.4		1.2	129.0
Chemical Costs	-	109.7	-	-	-	11.0	120.7		3.2	-	123.9		3.7	124.4
TOTAL	463.3	122.7	1683.8	132.3(3)	48.9	48.4	2499.4		21.7	43.2	2564.3		19.8	2519.2
Less Credit(4)			1090.0				1090.0				1090.0			1090.0
Net Total			593.8				1409.4				1474.3			1429.2

Wastewater Parameters	Raw Waste Load	NSPS No.1 Effluent Level	NSPS No. 2, PSES, and PSNS Effluent Level	NSPS No. 3 Effluent Level
Flow, gal/ton	1100	65	65	65
pH	8-11	6-9	6-9	6-9
Concentrations, mg/l				
Suspended Solids	4200	15	15	15
Fluoride	15	15	10	15
23 Chloroform	0.05	0.05	0.05	0.05
115 Arsenic	0.05	0.05	0.05	0.05
118 Cadmium	0.50	0.30	0.10	0.10
119 Chromium	5.00	0.80	0.25	0.10
120 Copper	0.50	0.15	0.10	0.10
122 Lead	1.00	0.30	0.25	0.15
123 Mercury	0.01	0.005	0.005	0.005
124 Nickel	0.50	0.30	0.10	0.10
125 Selenium	0.025	0.025	0.025	0.025
126 Silver	0.20	0.15	0.15	0.15
127 Thallium	0.10	0.10	0.10	0.10
128 Zinc	5.00	0.90	0.30	0.25

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(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D. Recycle 95%
E: Filtration
F: pH Adjustment with Acid
G: Lime Addition
H: Clarifier (Tube Plate Settler)
I: Sulfide Precipitation

TABLE VIII-42

NSPS, PSES AND PSNS MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Electric Furnaces
: Wet

Model Size-TPD : 1800
Oper. Days/Year: 365
Turns/Day : 3

C&TT Steps	NSPS Alternative 1						NSPS Alternative 2, PSES, and PSNS				NSPS Alternative 3		
	$A^{(3)}$	B	$C^{(3)}$	D	E	Total	A-E	F	G	Total	A-E	H	Total
Investment $ x 10^{-3}	1189	55	911	534	102	2791		45	92	2928		24	2815
Annual Costs $ x 10^{-3}													
Capital	51.1	2.3	39.2	23.0	4.4	120.0		1.9	4.0	125.9		1.0	121.0
Depreciation	118.9	5.5	91.1	53.4	10.2	279.1		4.5	9.2	292.8		2.4	281.5
Operation & Maintenance	41.6	1.9	31.9	18.7	3.6	97.7		1.6	3.2	102.5		0.9	98.6
Sludge Disposal[(1)]	-	-	385.7	-	-	385.7		-	-	385.7		-	385.7
Energy & Power	4.1	1.0	35.7	20.4(2)	0.5	41.3		0.7	0.6	42.6		0.3	41.6
Chemical Costs	-	41.4	-	-	-	41.4		0.5	-	41.9		0.6	42.0
TOTAL	215.7	52.1	582.6	95.1(2)	18.7	965.2		9.2	17.0	991.4		5.2	970.4
Less Credit(4)			21.3			21.3				21.3			21.3
Net Total			562.3			943.9				970.1			949.1

	Wastewater Parameters	Raw Waste Load	NSPS No.1 Effluent Level	NSPS No.2, PSES and PSNS Effluent Level	NSPS No.3 Effluent Level
	Flow, gal/ton	2100	50	50	50
	pH	6-9	6-9	6-9	6-9
	Concentrations, mg/l				
	Suspended Solids	3400	15	15	15
	Fluoride	50	50	20	50
4	Benzene	0.015	0.015	0.015	0.015
39	Fluoranthene	0.020	0.020	0.020	0.020
58	4-Nitrophenol	0.015	0.015	0.015	0.015
64	Pentachlorophenol	0.015	0.015	0.015	0.015
84	Pyrene	0.020	0.020	0.020	0.020
114	Antimony	0.70	0.10	0.10	0.10
115	Arsenic	2.0	0.10	0.10	0.10
118	Cadmium	4.0	1.9	0.10	0.10
119	Chromium	5.0	0.40	0.15	0.10
120	Copper	2.0	0.15	0.10	0.10
122	Lead	30.0	1.50	0.30	0.15
124	Nickel	0.05	0.05	0.05	0.05
126	Silver	0.06	0.06	0.06	0.06
128	Zinc	125	25	0.35	0.25

TABLE VIII-42
NSPS, PSES, AND PSNS MODEL COSTS: BASIS 7/1/78 DOLLARS
ELECTRIC FURNACES - WET
PAGE 2

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(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost as a credit is supplied for process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener
B: Coagulant Aid Addition
C: Vacuum Filter
D: Recycle 98%
E: Filtration
F: Lime Precipitation
G: Tube Plate Settler
H: Sulfide Precipitation

TABLE VIII-43

PSES MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Open Hearth Furnace
: Wet

Model Size-TPD : 6700
Oper. Days/Year: 365
Tons/Day : 3

C&TT Steps	A[3]	B	C	D[3]	E	F	G	H	Total
Investment $ x 10^{-3}	3030	76	444	1020	945	269	231	287	6302
Annual Costs $ x 10^{-3}									
Capital	130.3	3.3	19.1	43.9	40.6	11.6	9.9	12.4	271.1
Depreciation	303.0	7.6	44.4	102.0	94.5	26.9	23.1	28.7	630.2
Operation & Maintenance	106.0	2.7	15.5	35.7	33.1	9.4	8.1	10.1	220.6
Sludge Disposal	-	-	-	270.1	-	-	29.4	-	299.2
Energy & Power[1]	6.5	1.0	17.6	38.4	65.3[2]	2.5	0.5	4.9	71.4
Chemical Costs	-	139.3	67.9	-	-	203.6	-	-	410.8
TOTAL	545.8	153.9	164.5	490.1	168.2[2]	254.0	70.7	56.1	1903.3
Less Credit[4]				251.9					251.9
Net Total				238.2					1651.4

Wastewater Parameters	Raw Waste Load	PSES Effluent Level
Flow, gal/ton	1900	110
pH	3-7	6-9
Concentration, mg/l		
Suspended Solids	1100	15
Fluoride	110	20
120 Copper	2.0	0.10
122 Lead	0.6	0.15
128 Zinc	200	0.30

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(1) Costs are all power unless otherwise noted.
(2) Total does not include power costs as a credit is supplied for process water requirements.
(3) Treatment components are used in tandem.
(4) Credit for recovery of sludge to sinter plant.

KEY TO C&TT STEPS

A: Clarifier/Thickener	H: Filtration
B: Coagulant Aid Addition	F: Lime Precipitation
C: Neutralization with Lime	G: Tube Plate Settler
D: Vacuum Filter	

TABLE VIII-44

ENERGY REQUIREMENTS AT BPT AND BAT STEELMAKING SUBCATEGORY

(Energy requirements are expressed in millions of kilowatt hours per year for all plants within each segment)

	BPT		BAT No. 1		BAT No. 2		BAT No. 3	
	Energy Requirement	Percent of Industry Usage	Energy Requirement	Percent of Industry Usage	Energy Requirement	Percent of Industry Usage	Energy Requirement	Percent of Industry Usage
Basic Oxygen Furnace								
Semi-Wet	3.16	0.006	*	*	*	*	*	*
Wet-Suppressed Combustion	6.29	0.011	0.38	0.0007	0.94	0.002	0.58	0.001
Wet-Open Combustion	69.27	0.12	2.30	0.004	4.31	0.008	2.97	0.005
SUBTOTAL	78.72	0.14	2.68	0.005	5.25	0.009	3.55	0.006
Open Hearth								
Semi-Wet	1.29	0.002	*	*	*	*	*	*
Wet	7.62	0.013	0.59	0.001	0.95	0.002	0.78	0.001
SUBTOTAL	8.91	0.016	0.59	0.001	0.95	0.002	0.78	0.001
Electric Arc Furnace								
Semi-Wet	0.83	0.001	*	*	*	*	*	*
Wet	13.22	0.023	0.16	0.0003	0.58	0.001	0.26	0.0005
SUBTOTAL	14.05	0.025	0.16	0.0003	0.58	0.001	0.26	0.0005
TOTAL	101.68	0.18	3.43	0.006	6.78	0.012	4.33	0.008

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*: No BAT treatment alternatives were needed for these segments.

TABLE VIII-45

ENERGY REQUIRMENTS AT NSPS AND PRETREATMENT STEELMAKING - WET AIR POLLUTION CONTROL SYSTEMS

(Energy requirements are expressed in millions of kilowatt hours per year for the treatment models)

	NSPS No. 1 Energy Requirements	NSPS No. 2 Energy Requirements	NSPS No. 3 Energy Requirements	Pretreatment Energy Requirements
Basic Oxygen Furnace				
Wet-Suppressed Combustion	1.11	1.20	1.14	1.11
Wet-Open Combustion	5.11	5.26	5.16	5.11
Open Hearth Furnace				
Wet	NA	NA	NA	2.86
Electric Arc Furnace				
Wet	1.65	1.70	1.66	1.70

NA: Not applicable

TABLE VIII-46

SOLID WASTE GENERATION SUMMARY
NSPS AND PRETREATMENT
STEELMAKING SUBCATEGORY

(The values presented below are based on the various treatment models)

	NSPS No. 1		NSPS No. 2		NSPS No. 3		PSES and PSNS	
	Pounds/Ton	Tons/Year	Pounds/Ton	Tons/Year	Pounds/Ton	Tons/Year	Pounds/Ton	Tons/Year
Basic Oxygen Furnace								
Wet	0.982	950	*	*	*	*	0.982	950
Wet-Suppressed Combustion	12.12	16,370	12.17	16,440	12.13	16,380	12.12	16,370
Wet-Open Combustion	38.11	63,290	38.17	63,390	38.11	63,290	38.11	63,290
Open Hearth								
Semi-Wet	*	*	*	*	*	*	5.16	6,220
Wet	*	*	*	*	*	*	18.79	22,980
Electric Arc Furnace								
Semi-Wet	2.69	1,520	*	*	*	*	2.69	1,520
Wet	58.72	19.290	58.76	19,300	58.72	19,290	58.76	19,300

---

*: No treatment models were provided in these segments.

STEELMAKING SUBCATEGORY

SECTION IX

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

With the exception of the cases discussed below, the Agency is proposing Best Practicable Control Technology Currently Available limitations (BPT) for the various steelmaking operations which are identical to those originally promulgated in June, 1974.[1] Due to flow and raw wastewater quality differences, the Agency concluded that further segmentation of the wet air pollution control system segment of the basic oxygen furnace subdivision is appropriate to reflect suppressed combustion and open combustion operations. Also the original limitations made no distinction as to the types of air pollution control systems used for open hearth furnace operations. Therefore, in order to reflect actual operations in the industry, a segment for open hearth furnace operations with semi-wet air pollution control systems has been established. Also, the originally promulgated BPT effluent limitations for open hearth furnace operations (now called the wet air pollution control system segment) have been modified to reflect the additional effluent flow data provided in the DCPs and D-DCPs.

The subdivisions and segments established for the steelmaking subcategory are as follows:

Basic Oxygen Furnaces
    Semi-wet Air Pollution Control Systems
    Wet Air Pollution Control Systems - Suppressed Combustion
    Wet Air Pollution Control Systems - Open Combustion

Open Hearth Furnaces
    Semi-wet Air Pollution Control Systems
    Wet Air Pollution Control Systems

Electric Arc Furnaces
    Semi-wet Air Pollution Control Systems
    Wet Air Pollution Control Systems

As the June, 1974 development document[2] described the methods used in developing the original limitations, the discussion in this section focuses upon the achievability of those limitations and, where necessary, the demonstration of the basis for and substantiation of any adjustments to the limitations. A review of the treatment processes and effluent limitations associated with the steelmaking subdivisions follows.

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[1] Federal Register; Friday, June 28, 1974; Part II, Environmental Protection Agency; Iron and Steel Manufacturing Point Source Category; Effluent Guidelines and Standards; Pages 24114-24133.

[2] EPA-440/I-74-024-a, Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steel Making Segment of the Iron and Steel Manufacturing Point Source Category

Identification of BPT

The BPT model treatment system for the semi-wet air pollution control system segments of the basic oxygen furnace and electric arc furnace subdivisions include thickeners, coagulant aid addition, vacuum filters, and complete recycle. The newly developed semi-wet segment of the open hearth furnace subdivision also includes all of these components while adding an initial pH adjustment (with lime) step. In these models, all of the thickener effluent is recycled. Figure IX-1 depicts the treatment systems described above.

The BPT model treatment system for the wet air pollution control system segments of each of the three subdivisions incorporate the following components: thickeners, coagulant aid addition, vacuum filters, and recycle of most of the thickener effluent. In addition, the basic oxygen furnace wet segment models provided for the pH controlled addition of acid to the system blowdown (effluent). Also, the controlled addition of lime was included as an initial treatment step in the open hearth furnace BPT model treatment system. The use of lime for pH adjustment purposes in treatment and recycle systems is demonstrated within this steelmaking subdivision. Figure IX-2 depicts the treatment systems described above.

The proposed limitations do not require the installation of the model treatment system; any treatment systems which achieve the proposed limitations are acceptable. Table IX-1 summarizes the characteristics (for the BPT limited pollutants) of the various steelmaking process wastewaters. EPA survey data were used to determine the raw wastewater characteristics noted on this table. The proposed BPT effluent limitations, which represent 30-day average values, are presented in Table IX-2 for the steelmaking segments. As in the originally promulgated BPT effluent limitations, the proposed maximum daily effluent limitations are three times the average values.

Rationale for BPT

Treatment System

As noted in Section VII, each of the treatment system components incorporated in the BPT model treatment systems is in use at many of the plants in each of the steelmaking segments. Based upon that fact, the Agency believes that the use of each model treatment system, and each component therein, is substantiated.

The semi-wet segment of the open hearth furnace subdivision applies the treatment technologies incorporated in the semi-wet segments of the basic oxygen furnace and electric arc furnace subdivisions, i.e., no discharge of process wastewater pollutants to navigable waters. Table IX-3 presents a summary of the flow, recycle rate, and operational data for wet open hearth furnace operations. These data not only demonstrate the need for an adjustment of the originally developed open hearth treatment model effluent flow (50 gal/ton), but also provides the basis for developing the adjusted treatment model effluent flow (110 gal/ton). This table also provides support for the treatment model recycle rate of 94% (defined by the model applied and effluent flows).

Justification of BPT Effluent Limitations

Tables IX-4 through IX-6 present sampled plant and D-DCP effluent data which support the proposed BPT effluent limitations for the various steelmaking segments. In reviewing these tables, it should be noted that the proposed effluent limitations are achieved by some plants that use treatment system components which differ from those included in the various BPT model treatment systems (in particular, lower recycle rates and higher effluent flows). In addition, although separate segments (suppressed combustion and open combustion) have been established for BOF shops with wet air pollution control systems, the same proposed BPT effluent limitations apply (as demonstrated by the effluent justifications presented in Table IX-4).

Generally, the remaining sampled plants were unable to achieve the respective proposed effluent limitations due to the absence of or the use of insufficient recycle. By reducing effluent flows (incorporating greater recycle rates) to a level approximating the respective model effluent flows, these plants would be able to achieve the appropriate proposed BPT effluent limitations. The data presented in Tables IX-4 through IX-6 justify the proposed effluent limitations for the steelmaking subcategory.

TABLE IX-1
BPT MODEL TREATMENT SYSTEM RAW WASTEWATER CHARACTERISTICS
STEELMAKING SUBCATEGORY

OPERATIONS		SUSPENDED SOLIDS (mg/l)	pH (units)
BASIC OXYGEN FURNACE	Semi-Wet	375	10-12
	Wet: Suppressed Combustion	1500	8-11
	Wet: Open Combustion	4200	8-11
OPEN HEARTH FURNACE	Semi-Wet	500	2-3
	Wet	1100	3-7
ELECTRIC ARC FURNACE	Semi-Wet	2200	6-9
	Wet	3400	6-9

TABLE IX-2
BPT EFFLUENT LIMITATIONS GUIDELINES
STEELMAKING SUBCATEGORY

OPERATION		UNITS	TOTAL SUSPENDED SOLIDS	pH (units)
BASIC OXYGEN FURNACE	Semi-Wet	lb/1000 lb	No discharge of process wastewater pollutants to navigable waters.	
		mg/l		
	Wet: Suppressed Combustion	lb/1000 lb	0.0104	Within the range 6.0 to 9.0
		mg/l	50	
	Wet: Open Combustion	lb/1000 lb	0.0104	Within the range 6.0 to 9.0
		mg/l	50	
OPEN HEARTH FURNACE	Semi-Wet	lb/1000 lb	No discharge of process wastewater pollutants to navigable waters.	
		mg/l		
	Wet	lb/1000 lb	0.0229	Within the range 6.0 to 9.0
		mg/l	50	
ELECTRIC ARC FURNACE	Semi-Wet	lb/1000 lb	No discharge of process wastewater pollutants to navigable waters.	
		mg/l		
	Wet	lb/1000 lb	0.0104	Within the range 6.0 to 9.0
		mg/l	50	

TABLE IX-3

SUMMARY OF FLOWS AND RECYCLE RATES OPEN HEARTH FURNACE - WET

Plant Code	Applied Flow (gal/ton)	Discharge Flow (gal/ton)	Operating Mode	Basis
0948C	2679	80*	RTP-97.0	DCP
0060	4392	105*	RTP-97.6	D-DCP
0112A	914	114*	RUP and RTP-87.5	D-DCP
0492A	506	359	RTP-29.1	VISIT

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*: Effluent flows which approach or are lower than the BPT treatment model system effluent flow of 110 gal/ton.

TABLE IX-4

JUSTIFICATION OF BPT EFFLUENT LIMITATIONS BASIC OXYGEN FURNACE SUBDIVISION

	Suspended Solids (lb/1000 lb)	pH (Units)	C&TT Components
Semi-Wet			
Proposed BPT Limitations	No discharge of process wastewater pollutants to navigable waters.		FLP,T,VF,RTP-100
Plants			
R(0432A)	No discharge	-	DR,FLP,RTP-100
0920B(1)	No discharge, applied waters are completely evaporated	-	NA
Wet(2)			
Proposed BPT Limitations	0.0104	6-9	FLP,T,VF,RTP-95,NA
Plants			
S(0060)*	0.00478	9.3	Classifier,FLP,T,VF, RTP-94.7
V(0584F)**	0.0055	6.4	Classifier,FLP,T,VF, RTP-87.3
038(0684F)*	0.00177	7.5	Desiltors,T,VF,TP, FLP,FLL,RTP-94.2
0384A(3)*	0.00534	9.3	Classifier,T,CL, RTP-94.0
0856N(3)*	0.00553	7.9	T,CL,FLP,RTP-96.9

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(1) Based on the DCP response (refer to the General Summary Tables).
(2) These effluent limitations pertain to both the suppressed and open combustion subsegments.
(3) Based on D-DCP analytical data.

NA: Not Applicable
* : Suppressed Combustion Operation.
**: Open Combustion Operation.

TABLE IX-5

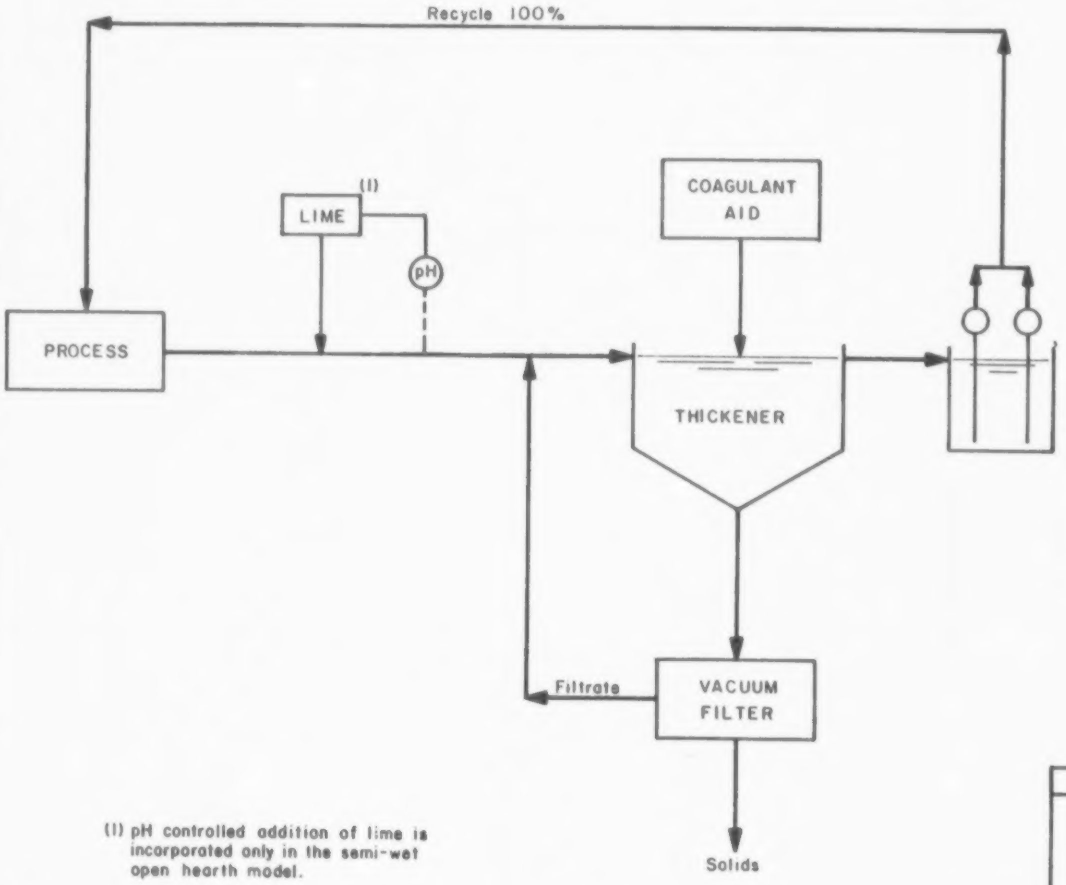
JUSTIFICATION OF BPT EFFLUENT LIMITATIONS OPEN HEARTH FURNACE SUBDIVISION

	Suspended Solids(lb/1000 lb)	pH (Units)	C&TT Components
Wet			
Proposed BPT Limitations	0.0229	6-9	NL,FLP,T,VF,RTP-94
Originally Promulgated BPT Limitations (6/74)	0.0104	6-9	NL,FLP,T,VF,RTP-97
Plants			
W(0112A)	0.017	2.6	T,RTP and RUP-91

TABLE IX-6

JUSTIFICATION OF BPT EFFLUENT LIMITATIONS ELECTRIC ARC FURNACE SUBDIVISION

	Suspended Solids(lb/1000 lb)	pH (Units)	C&TT Components
Semi-Wet			
Proposed BPT Limitations	No discharge of process wastewater pollutants to navigable waters		FLP,T,VF,RTP-100
Plants			
Z(0584A)	No discharge	-	DR,RTP-100
Wet			
Proposed BPT Limitations	0.0104	6-9	FLP,T,VF,RTP-98
Plants			
051(0612)	0.0062	7.6	CL,VF,RTP-98.5


Recycle 100%
LIME
(1)
pH
PROCESS
COAGULANT AID
THICKENER
Filtrate
VACUUM FILTER
Solids

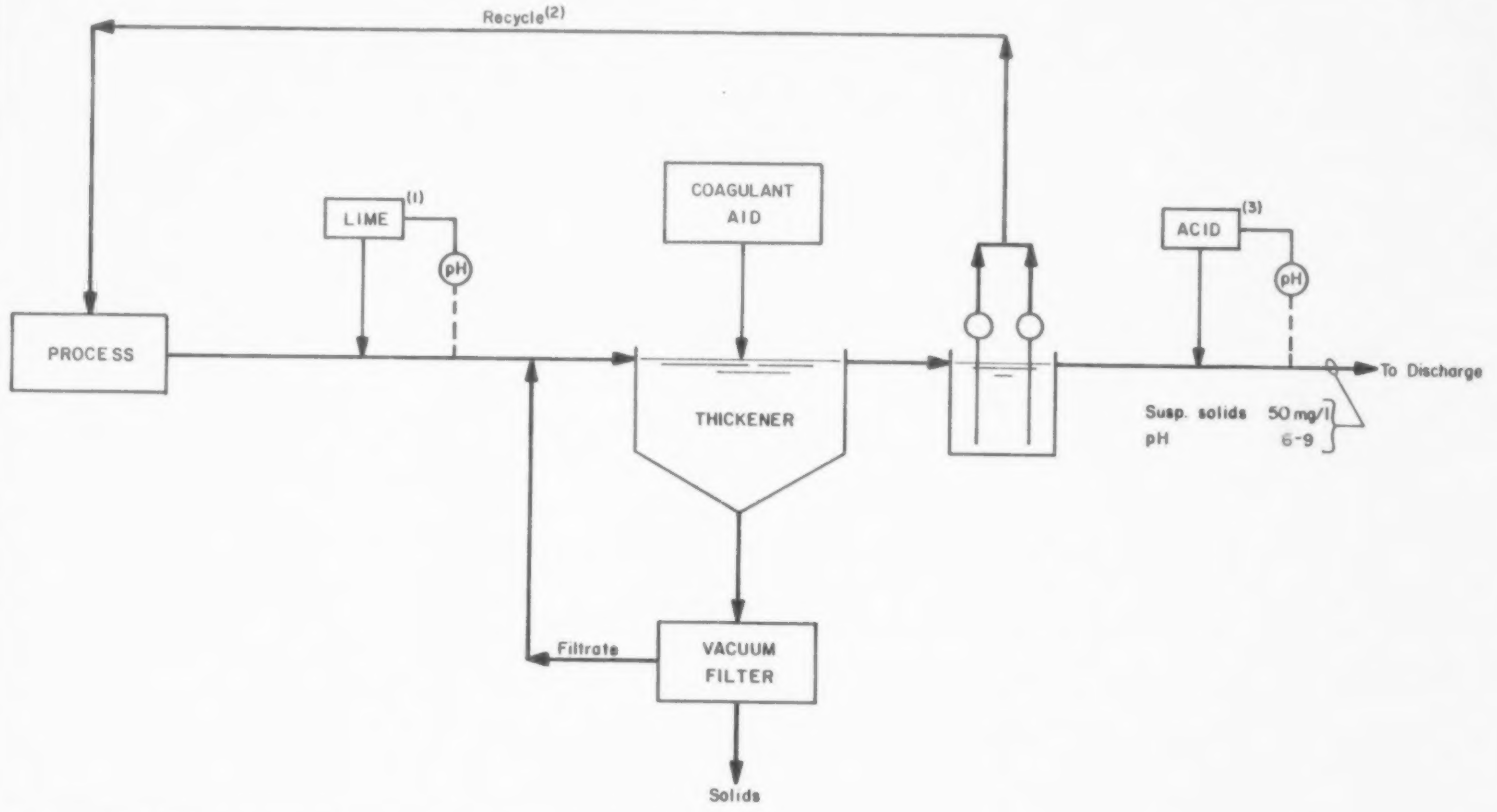
(1) pH controlled addition of lime is incorporated only in the semi-wet open hearth model.

ENVIRONMENTAL PROTECTION AGENCY

STEELMAKING SUBCATEGORY
SEMI-WET AIR POLLUTION CONTROL SYSTEMS
BPT TREATMENT MODELS

Dwn. 6/3/80

FIGURE IX-1


Recycle(2)
LIME(1)
pH
COAGULANT AID
ACID(3)
pH
PROCESS
THICKENER
To Discharge
Susp. solids 50 mg/l
pH 6-9
Filtrate
VACUUM FILTER
Solids

(1) pH controlled addition of lime is incorporated only in the open hearth model.

(2) Recycle percentages: 95% - Basic Oxygen Furnace
94% - Open Hearth Furnace
98% - Electric Arc Furnace

(3) pH controlled addition of acid is incorporated only in the basic oxygen furnace model.

ENVIRONMENTAL PROTECTION AGENCY

STEELMAKING SUBCATEGORY
WET AIR POLLUTION CONTROL SYSTEMS
BPT TREATMENT MODELS

Dwn. 6/4/80

FIGURE IX-2

STEELMAKING SUBCATEGORY

SECTION X

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Introduction

This section identifies three BAT alternative treatment systems considered by the Agency, and the resulting effluent levels, for the steelmaking subdivisions. In addition, the rationale for selecting treatment technologies, discharge flow rates, and effluent pollutant concentrations are discussed. Finally, the proposed BAT effluent limitations for each segment are presented.

Identification of BAT

Based upon the information presented in Sections III through VIII, the Agency developed the following treatment technologies (as add-ons to the BPT model treatment systems) to attain BAT for the steelmaking subdivisions.

As the proposed BPT effluent limitations for the semi-wet air pollution control system segments provide for no process wastewater pollutant discharges, the proposed BAT effluent limitations for these segments also provide for no discharge of process wastewater pollutants to navigable waters.

Following are the treatment technologies developed for those steelmaking operations equipped with wet air pollution control systems.

A. BAT Alternative No. 1

In the first BAT alternative, filtration of the BPT treatment system blowdown is provided to reduce the effluent levels of those toxic metals entrained in the suspended solids. In the case of the basic oxygen furnace subsegments, the final treatment step involves the addition of acid to control the treated effluent pH. This step, a component of the BPT model treatment system, has been relocated within the treatment sequence.

B. BAT Alternative No. 2

In this treatment alternative, lime addition and gravity sedimentation are provided prior to the filtration component outlined in the first alternative. Lime addition is incorporated for the purpose of providing additional toxic metals and fluoride removal. Sedimentation of the solids generated in this process is provided in inclined plate separators. As noted above, pH adjustment of the treated effluent is provided as the last treatment step in the basic oxygen furnace subsegments.

C. BAT Alternative No. 3

In this treatment alternative, sulfide precipitation is included prior to the filtration component retained from the first treatment alternative. Sulfide precipitation techniques are included to provide greater reductions in toxic metals. loads. As noted previously, pH adjustment is relocated from the BPT model treatment system in the basic oxygen furnace subsegments.

Figure X-1 illustrates the three BAT alternative treatment systems for the steelmaking subdivisions. The treatment technologies shown represent those technologies in use at one or more plants, or demonstrated in other wastewater treatment applications, and considered to be capable of attaining the respective BAT effluent levels. The applicability of each of the treatment methods presented above is reviewed below.

The proposed limitations for the pollutants considered for limitation at BAT are presented in Table X-1. Section VI presents the rationale for the selection of those toxic metal pollutants considered for limitations. As noted in Volume I, treatment of those toxic pollutants found at high levels in the process wastewaters will result in a similar or greater degree of treatment for those similar toxic pollutants found at lower levels. Although several toxic metals are found in the wastewaters of the various steelmaking processes, the Agency is proposing limitations and standards for only three metals at the BAT, NSPS, PSES, and PSNS levels of treatment in each wet air pollution control system segment. The Agency selected those pollutants for which limitations and standards are being proposed based upon the following considerations: the relative levels, loads, and environmental impacts of each pollutant; the ability of the selected toxic metal pollutants to serve as indicators of overall and toxic metals treatment performance; and, the need to develop practical monitoring requirements for the industry. Although not found to be significant in open hearth-wet segment wastewaters (refer to Section VI), chromium was added to the list of pollutants proposed for limitation in this segment in order to establish comparable lists of limited pollutants in each wet steelmaking segment. Recognition is thereby provided of the cotreatment possiblities among these segments and with other compatible wastewaters. Control of the toxic metals listed on Table X-1 will also result in control of the other toxic metals. Investment and annual costs for the various BAT treatment systems are presented in Tables VIII-29 to VIII-32.

Rationale for the Selection of the BAT Alternatives

The following discussion presents the rationale for the selection of the BAT alternative treatment systems, for the determination of the effluent flows, and for the determination of the effluent concentration levels of the limited pollutants.

Treatment Technologies

As noted in Section IX, data obtained since the development of the original basic oxygen furnace effluent limitations led the Agency to conclude that further segmentation of the basic oxygen furnace wet air pollution control segment is appropriate. The indicated segments reflect the distinctions between open combustion and suppressed combustion operations. All of the BAT alternative treatment system components are applied to the blowdown of the BPT model treatment and recycle systems.

Filtration is included in all of the BAT alternative treatment systems as a means of reducing the effluent toxic metals loads. Although in use at only one BOF shop, filtration has been included in the steelmaking BAT alternative treatment systems because of its widely demonstrated capabilities in various steel industry wastewater treatment applications. This transfer of technology is primarily based upon the observation that steelmaking process wastewaters will respond to filtration in a manner basically similar to that of the reference wastewaters. The similarities arise from the fact that some toxic metals are entrained within the particulate matter suspended in the process wastewaters and that the suspended matter are principally discrete particles. When properly designed (media selection, mode of filter operation, system design) and properly operated (correct backwash sequence, flows, and duration, avoidance of fouling) substantial reductions in suspended solids (and those pollutants entrained therein) effluent levels and loads can be achieved.

The lime precipitation and gravity sedimentation treatment components of the second treatment alternative are provided to remove toxic metals and fluoride. The toxic metals level reductions accomplished in the second treatment alternative for each subcategory result not only from the filtration step retained from the first alternative, but also from the formation of hydroxide precipitates and from the entrainment of particulate matter, which contains toxic metals, in the solids and precipitates formed as a result of lime addition. As noted above, these solids and precipitates are removed by sedimentation and filtration. The capabilities of lime addition and precipitation with respect to toxic metals removal have been demonstrated in wastewater treatment applications in this subcategory, in this industry, and in other industries. Widely used in the steelmaking subcategories, lime addition also provides a convenient source of calcium for the formation of calcium fluoride precipitates. The use of lime in fluoride precipitation procedures has also been demonstrated in a variety of industrial wastewater treatment applications.

Sulfide precipitation is incorporated in the third treatment alternative of each segment for the purpose of removing toxic metal pollutants. Although not employed in this subcategory, the effectiveness of this treatment technology has been demonstrated in the electroplating industry, in pilot studies in this subcategory, and in wastewater treatment applications in other metals manufacturing operations.

Flows

Following are the applied and effluent flows incorporated in the BAT alternative treatment systems of each segment.

Operation	Applied Flow (gal/ton)	BAT Effluent Flow (gal/ton)
Basic Oxygen Furnace-Wet-Suppressed Combustion	1000	50
Basic Oxygen Furnace-Wet-Open Combustion	1100	65
Open Hearth Furnace-Wet	1900	110
Electric Arc Furnace-Wet	2100	50

No recycle steps additional to those of the BPT model systems are included in any of the BAT alternative treatment systems. Refer to Tables X-2 through X-4 for data which support the above treatment model effluent flows.

Referring to Table X-2, the BOF - wet-suppressed combustion effluent flow is achieved by two of the total of six plants in this subsegment. It is important to note that the effluent flows at these two plants are based upon data either obtained during a sampling visit or provided in a D-DCP response (thus representing long-term data). The effluent flow for the BOF - wet-open combustion BAT model was established on the basis of analytical data provided in the D-DCP response from one of the plants in this subsegment. D-DCP data are significant because these data relate to periods of at least a year.

Referring to Table X-3, of the four plants in the wet segment of the open hearth furnace subdivision, two plants have effluent flows less than the model BAT effluent flow and one plant's effluent flow closely approaches that of the BAT model treatment system. The data for two of the three plants which support the model treatment effluent flow are based upon D-DCP responses. Referring to Table X-4, two of the ten plants in the wet segment of the electric arc furnace subdivision support the effluent flow used in the BAT treatment model for this segment. The effluent flow of 45 gal/ton for Plant 0612 was established on the basis of D-DCP data. The data noted above support the ability of all steelmaking wet gas cleaning system operations to reduce effluent flows to the levels incorporated in the respective segment treatment models.

Wastewater Quality

The average and maximum effluent concentrations for the various pollutants considered in each BAT alternative treatment system are summarized for the wet segments on Table X-1.

A. Nonconventional Pollutants

As noted previously in this section, fluoride (a nonconventional pollutant) was levels and loads were considered in the development of the BAT alternative treatment system for the steelmaking subdivisions. It must be recognized that fluoride, although not included in the list of toxic pollutants, has been demonstrated to be environmentally detrimental at elevated concentrations. However, it will receive adequate treatment in the BAT alternative treatment systems. The fluoride effluent level and load reductions provided in the second treatment alternative, as a result of precipitation with lime, were established on the basis of capabilities demonstrated in various industrial wastewater treatment applications in this and in other subcategories. The treatment capabilities, with respect to effluent fluoride levels, of this technology were also confirmed by a review of the technical literature pertaining to this subject. However, the Agency is not proposing BAT effluent limitations for fluoride.

B. Toxic Metals Pollutants

Refer to Table X-1 for a summary of the toxic metals effluent levels and loads provided in the various BAT alternative treatment systems.

1. BAT Alternative No. 1

To determine the effluent concentrations for the toxic metal pollutants in the first BAT alternatives, the Agency evaluated analytical data from a variety of sources. Pilot study data in this subcategory were reviewed to determine the toxic metal pollutant removal capabilities of filtration systems used in wastewater treatment applications in this subcategory. In addition, the steelmaking analytical data were reviewed to determine the toxic metals removal performance to be achieved as a result of controlling suspended solids levels and loads. Reference is made to Volume I, Appendix A, for the derivation of toxic metals performance standards.

2. BAT Alternative No. 2

The toxic metals removals incorporated in the second BAT alternative treatment system result from lime precipitation and subsequent suspended solids removal. The toxic metal pollutant levels in the second alternatives are reduced (significantly in some instances) beyond the levels accomplished in the first alternatives. The toxic metals treatment capabilities of this alternative's treatment technologies were established on the basis of pilot studies in this subcategory and on the basis of samled plant analytical data. Refer to Volume I, Appendix A for details and data of the pilot study.

3. BAT Alternative No. 3

The third BAT alternatives incorporate sulfide precipitation systems along with the filtration systems provided in the first BAT alternatives. The capabilities of this technology were established on the basis of pilot studies performed at an electric arc furnace-wet operation. Refer to Volume I, Appendix A for the details of this study. The toxic metals effluents which can be achieved with this treatment technology were developed on the basis of a review of various sources of data (refer to Volume I). As steelmaking process wastewaters contain a number of the same toxic metal pollutants found in the wastewaters in the data review and the dissolved metals and metal hydroxide precipitates will behave in a similar manner, the transfer of sulfide precipitation technology is valid and appropriate.

Effluent Limitations for BAT Alternatives

The Agency calculated effluent limitations for the BAT alternative treatment systems by multiplying, along with the appropriate conversion factors, the effluent flows by the effluent concentration of each pollutant. The bases for the effluent flows and concentrations have been previously discussed and substantiated in this section. Accordingly, the Agency believes that the resultant effluent limitations are justified. Table X-1 presents the effluent limitations associated with the alternative treatment systems.

Selection of a BAT Alternative

The Agency selected BAT No. 2, in each of the wet steelmaking segments, as the model treatment systems upon which the proposed BAT effluent limitations for each segment are based. The selection process involved a review of the toxicity levels of each pollutant considered for limitation at BAT, the effluent levels of these pollutants in each treatment alternative, and the annual costs of each alternative. On the basis of these considerations, the Agency determined that the selected BAT alternatives noted above provide the most significant benefits with regard to reductions in toxic pollutant effluent loads.

While the third alternatives in each wet air pollution control system segment incorporate sulfide precipitation, this technology is not currently used in steelmaking operations, and does not provide significant additional pollutant removals.

The proposed BAT effluent limitations are presented on Table X-1 in the column for the second treatment alternative.

The proposed chromium limit for the open hearth-wet segment is based upon the concentration value noted for the selected BOF-wet-suppressed combustion alternative applied to the open hearth - wet segment model treatment system effluent flow. As the BOF - wet-suppressed combustion model treatment raw waste chromium concentration was lower than the BOF - wet-open combustion or EAF - wet model concentrations, the effluent level for this system was considered to be the most appropriate level for the purpose of facilitating combined treatment of compatible wastes. As noted previously in this section, chromium was not found in open hearth - wet process wastewaters at levels considered to be signficant.

It must be noted that the sampled plant analytical data indicate that the proposed BAT limitations can be attained by treatment systems which do not include all of the BAT model treatment components. In particular, Plant 0684F achieved the proposed limitations for its segment with only the lime addition and inclined plate separator components of the BAT model treatment system. Therefore, the Agency believes that the proposed BAT limitations can be achieved at less cost than projected for BAT.

TABLE X-1
BAT EFFLUENT LEVELS AND LOADS
STEELMAKING SUBCATEGORY

SUBDIVISION	SEGMENT			BAT ALTERNATIVE No. 1		BAT ALTERNATIVE No. 2		BAT ALTERNATIVE No. 3	
				CONCENTRATION BASIS (mg/l)	EFFLUENT LIMITATIONS (kg/kkg of Product)	CONCENTRATION BASIS (mg/l)	EFFLUENT LIMITATIONS (kg/kkg of Product)	CONCENTRATION BASIS (mg/l)	EFFLUENT LIMITATIONS (kg/kkg of Product)
BASIC OXYGEN FURNACE	WET: SUPPRESSED COMBUSTION	DISCHARGE FLOW (gal/ton)		50	——	50	——	50	——
		CHROMIUM	Ave.	0.10	0.000021	0.10	0.000021	0.10	0.000021
			Max.	0.30	0.000063	0.30	0.000063	0.30	0.000063
		LEAD	Ave.	2.00	0.000417	0.30	0.000063	0.15	0.000031
			Max.	6.00	0.00125	0.90	0.000188	0.45	0.000094
		ZINC	Ave.	0.90	0.000188	0.30	0.000063	0.25	0.000052
			Max.	2.70	0.000563	0.90	0.000188	0.75	0.000156
	WET: OPEN COMBUSTION	DISCHARGE FLOW (gal/ton)		65	——	65	——	65	——
		CHROMIUM	Ave.	0.80	0.000217	0.25	0.000068	0.10	0.000027
			Max.	2.40	0.000651	0.75	0.000203	0.30	0.000081
		LEAD	Ave.	0.30	0.000081	0.25	0.000068	0.15	0.000041
			Max.	0.90	0.000244	0.75	0.000203	0.45	0.000122
		ZINC	Ave.	0.90	0.000244	0.30	0.000081	0.25	0.000068
			Max.	2.70	0.000732	0.90	0.000244	0.75	0.000203
OPEN HEARTH FURNACE	WET AIR POLLUTION CONTROL SYSTEMS	DISCHARGE FLOW (gal/ton)		110	——	110	——	110	——
		CHROMIUM	Ave.	0.10	0.000046	0.10	0.000046	0.10	0.000046
			Max.	0.30	0.000138	0.30	0.000138	0.30	0.000138
		LEAD	Ave.	0.25	0.000115	0.15	0.000069	0.15	0.000069
			Max.	0.75	0.000344	0.45	0.000206	0.45	0.000206
		ZINC	Ave.	4.50	0.00206	0.30	0.000138	0.25	0.000115
			Max.	13.5	0.00619	0.90	0.000413	0.75	0.000344
ELECTRIC ARC FURNACE	WET AIR POLLUTION CONTROL SYSTEMS	DISCHARGE FLOW (gal/ton)		50	——	50	——	50	——
		CHROMIUM	Ave.	0.40	0.000083	0.15	0.000031	0.10	0.000021
			Max.	1.20	0.000250	0.45	0.000094	0.30	0.000063
		LEAD	Ave.	1.50	0.000313	0.30	0.000063	0.15	0.000031
			Max.	4.50	0.000938	0.90	0.000188	0.45	0.000094
		ZINC	Ave.	25	0.00521	0.35	0.000073	0.25	0.000052
			Max.	75	0.0156	1.05	0.000219	0.75	0.000156

Proposed BAT Effluent Limitations are based upon BAT Alternative No. 2 (the selected alternative).

TABLE X-2

SUMMARY OF FLOWS
STEELMAKING SUBCATEGORY
BASIC OXYGEN FURNACES - WET

Plant Code	Applied Flow (gal/ton)	Effluent Flow (gal/ton)	Basis
Suppressed Combustion			
0684F	569	33	VISIT
0856N	1278	39	D-DCP
0060	1897	75	DCP
0384A	1327	80	D-DCP
0684H	1129	113	D-DCP
0528A	1818	1818	DCP
Open Combustion			
0584F	262	65	D-DCP
0384A	977	99	DCP
0868A	1114	113	VISIT
0856R	1296	118	DCP
0860B	1263	146	D-DCP
0920N	227	149	DCP
0860B	1285	201	DCP
0112D	454	244	VISIT
0724A	1558	312	D-DCP
0112A	1315	437	DCP
0020B	2264	637	D-DCP
0860H	1946	1596	DCP
0856B	241	241	VISIT
0112B	1824	1801	DCP
0248A	2072	1934	DCP

TABLE X-3

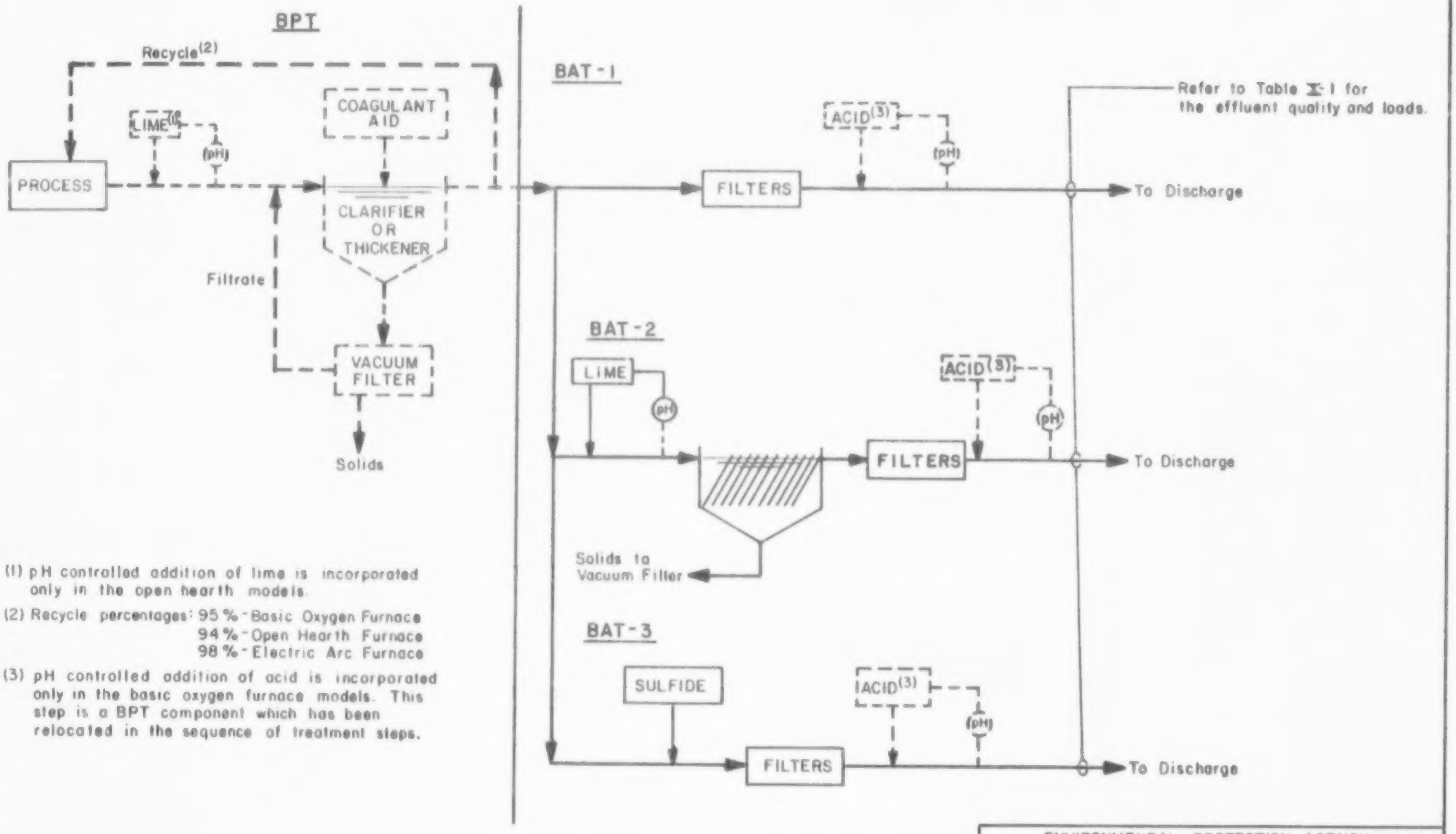
SUMMARY OF FLOWS
STEELMAKING SUBCATEGORY
OPEN HEARTH FURNACES - WET

Plant Code	Applied Flow (gal/ton)	Effluent Flow (gal/ton)	Basis
0948C	2679	80	DCP
0060	4392	105	D-DCP
0112A	914	114	D-DCP
0492A	506	359	VISIT

TABLE X-4

SUMMARY OF FLOWS
STEELMAKING SUBCATEGORY
ELECTRIC ARC FURNACES - WET

Plant Code	Applied Flow (gal/ton)	Effluent Flow (gal/ton)	Basis
0940	-	0	DCP
0612	2412	45	D-DCP
0856F	2092	104	DCP
0060D	829	232	D-DCP
0868B	2625	234	D-DCP
0060F	2300	238	VISIT
0860H	2353	776	DCP
0492A	1178	836	VISIT
0860H	2330	1212	DCP
0528A	3512	3512	DCP


BPT
Recycle(2)
PROCESS
LIME(1)
(pH)
COAGULANT AID
CLARIFIER OR THICKENER
Filtrate
VACUUM FILTER
Solids
BAT-1
FILTERS
ACID(3)
(pH)
To Discharge
Refer to Table X-1 for the effluent quality and loads.
BAT-2
LIME
(pH)
FILTERS
ACID(3)
(pH)
To Discharge
Solids to Vacuum Filter
BAT-3
SULFIDE
FILTERS
ACID(3)
(pH)
To Discharge

(1) pH controlled addition of lime is incorporated only in the open hearth models.

(2) Recycle percentages: 95% - Basic Oxygen Furnace
94% - Open Hearth Furnace
98% - Electric Arc Furnace

(3) pH controlled addition of acid is incorporated only in the basic oxygen furnace models. This step is a BPT component which has been relocated in the sequence of treatment steps.

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STEEL INDUSTRY STUDY
STEELMAKING SUBCATEGORY
WET AIR POLLUTION CONTROL SYSTEMS
BAT TREATMENT MODELS

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FIGURE X-1

STEELMAKING SUBCATEGORY

SECTION XI

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

Introduction

The 1977 Amendments added Section 301(b)(4)(E) to the Act, establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in Section 304(g)(4) - BOD, TSS, fecal coliform and pH - and any additional pollutants defined by the Administrator as "conventional." On July 28, 1978, EPA proposed that COD, oil and grease, and phosphorus be added to the conventional pollutant list (43 Fed. Reg. 32857). Only oil and grease was added.

BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. BCT requires that limitations for conventional pollutants be assessed in light of a "cost-reasonableness" test, which involves a comparison of the cost and level of reduction of conventional pollutants from the discharge of POTWs to the cost and level of reduction of such pollutants from a class or category of industrial sources. As part of its review of BAT for certain "secondary" industries, EPA proposed methodology for this cost test. (See 43 Fed. Reg. 37570, August 23, 1978).

Methodology

The BCT methodology is described in Volume I.

Development of BCT Limitations

For the steelmaking subdivisions, the BCT cost test was applied to the costs incurred and conventional pollutant load removals achieved in proceeding from BPT to the levels of treatment provided in each BCT alternative treatment system for the wet air pollution control system segments. As the proposed BPT and BAT effluent limitations for the semi-wet segments are identical, the BCT effluent limitations for these segments will also be identical (i.e., no discharge of process wastewater pollutants to navigable waters).

The BCT cost test was applied to the BCT alternative treatment systems for each wet air pollution control system segment. The conventional pollutant treatment costs determined by applying the BCT cost test to the various alternatives are shown below:

Segment	Conventional Pollutant Treatment Costs ($/lb)
BOF - Wet-Suppressed	
*BCT-1 (BAT-1 and 3)	0.53
BCT-2 (BAT-2)	1.54
BOF - Wet-Open	
*BCT-1 (BAT-1 and 3)	1.16
BCT-2 (BAT-2)	2.18
Open Hearth - Wet	
*BCT-1 (BAT-1 and 3)	0.71
BCT-2 (BAT-2)	1.61
EAF - Wet	
BCT-1 (BAT-1 and 3)	1.95
BCT-2 (BAT-2)	3.72

*: Selected alternatives.

As the costs for the selected alternatives in the BOF and open hearth wet sments are lower than the reference POTW conventional pollutant treatment cost of $1.34/lb, these alternatives pass the BCT cost test and were, therefore, selected. However, as the treatment costs for the alternative in the EAF segment are greater than the reference treatment cost, these alternatives do not pass the BCT cost test. Figure XI-1 illustrates the BCT alternative treatment systems for the wet segments of the steelmaking subdivisions.

The suspended solids effluent level of 15 mg/l incorporated in the treatment models for the wet segments of the BOF and Open Hearth subdivisions was developed on the basis of a statistical review of long-term analytical data from several wastewater filtration operations. Refer to Appendix A of Volume I for a detailed review of the statistical procedures used to develop the 15 mg/l, 30-day average suspended solids performance standards for filtration operations.

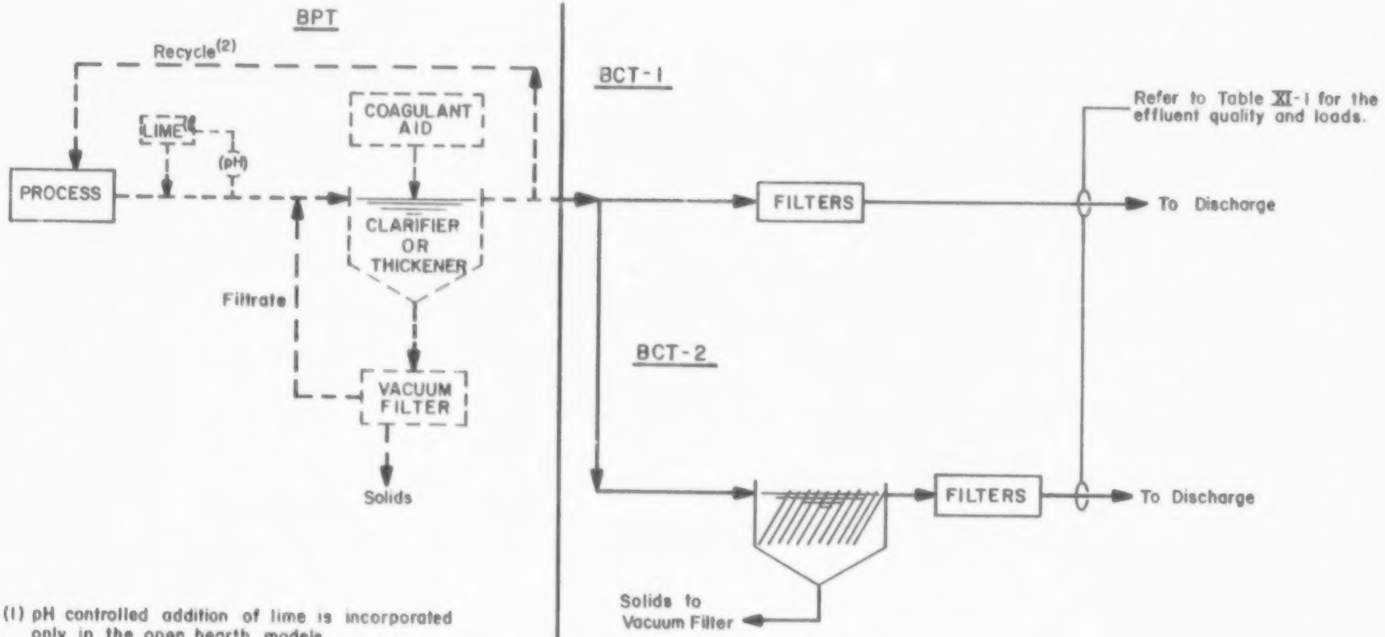
As BCT controls pertain only to the removal of conventional pollutants, the proposed BCT effluent limitations for the steelmaking subdivisions apply to suspended solids and pH only. The BCT effluent limitations for the BOF and open hearth wet air pollution control system segments, presented on Table XI-1, are based upon the suspended solids effluent levels achieved by the BCT model treatment systems for these segments.

The proposed BCT limitations for the electric arc furnace wet air pollution control system segment (refer to Table XI-1) are the same as the proposed BPT limitations. This action is taken because conventional pollutant treatment costs of the BCT model treatment system for this segment did not compare favorably with the conventional pollutant treatment costs of a POTW.

Proposed BCT limitations for the semi-wet segments are also equal to the respective proposed BPT limitations (i.e., no discharge of wastewater pollutants to navigable waters).

TABLE XI-1
PROPOSED BCT EFFLUENT LIMITATIONS GUIDELINES
STEELMAKING SUBCATEGORY

SUBDIVISION	SEGMENT	TOTAL SUSPENDED SOLIDS (kg/kkg of product)		pH
BASIC OXYGEN FURNACE	SEMI-WET	No discharge of process wastewater pollutants to navigable waters.		
	WET-SUPPRESSED COMBUSTION	Ave.	0.00313	Within the range 6.0 to 9.0
		Max.	0.00834	
	WET-OPEN COMBUSTION	Ave.	0.00407	Within the range 6.0 to 9.0
		Max.	0.0108	
OPEN HEARTH FURNACE	SEMI-WET	No discharge of process wastewater pollutants to navigable waters.		
	WET	Ave.	0.00688	Within the range 6.0 to 9.0
		Max.	0.0183	
ELECTRIC ARC FURNACE	SEMI-WET	No discharge of process wastewater pollutants to navigable waters.		
	WET	Ave.	0.0104	Within the range 6.0 to 9.0
		Max.	0.0312	


BPT
Recycle(2)
LIME(1)
(pH)
PROCESS
COAGULANT AID
CLARIFIER OR THICKENER
Filtrate
VACUUM FILTER
Solids
BCT-1
BCT-2
FILTERS
FILTERS
To Discharge
To Discharge
Refer to Table XI-1 for the effluent quality and loads.
Solids to Vacuum Filter

(1) pH controlled addition of lime is incorporated only in the open hearth models.

(2) Recycle percentages: 95% - Basic Oxygen Furnace
94% - Open Hearth Furnace
98% - Electric Arc Furnace

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STEEL INDUSTRY STUDY
STEELMAKING SUBCATEGORY
WET AIR POLLUTION CONTROL SYSTEMS
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FIGURE XI-1

STEELMAKING SUBCATEGORY

SECTION XII

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF NEW SOURCE PERFORMANCE STANDARDS

Introduction

A new source is defined as any source constructed after the proposal of new source performance standards (NSPS). NSPS is to consider the degree of effluent reduction achievable through the application of the best available demonstrated control technology (BADCT), processes, operating methods, or other alternatives, including where practicable, a standard permitting no discharge of pollutants. Although proposed for the semi-wet air pollution control system segments, zero discharge of process wastewater pollutants to a receiving stream is not a feasible treatment alternative for the wet air pollution control system segments. As discussed in Section VII, there are no apparent technologies, except evaporative systems, which could be generally applied to those steelmaking operations with wet air pollution control systems to achieve "zero discharge". However, evaporative systems were found to be neither an economical nor a demonstrated means of attaining "zero discharge" for wet air pollution control systems.

Identification of NSPS

Due to economic and environmental disadvantages, open hearth furnace capacity has been and will continue to decrease, while being replaced with BOF or electric arc furnace steelmaking production capacity. Because the Agency does not expect any new open hearth furnaces to be built, no NSPS alternative treatment systems were developed or effluent standards proposed for the semi-wet and wet segments of the open hearth furnace subdivision.

In addition, economic and energy consumption advantages favor the construction of either wet or dry air pollution control systems over semi-wet systems and of wet-supressed combustion systems over wet-open combustion systems. However, since these trends are not as predominant as those noted above for open hearth furnace operations, NSPS treatment alternatives and effluent standards were developed for all steelmaking segments other than open hearth operations.

NSPS for Semi-wet Air Pollution Control System Segments

The NSPS model treatment systems for the semi-wet air pollution control system segments of the BOF and EAF subcategories are identical to the BPT model treatment systems. The initial step of the treatment system provides gravity sedimentation of the process wastewaters in a thickener. A coagulant aid is added to the raw wastewaters at the thickener inlet to enhance suspended solids removal capabilities. Sludges generated in the treatment process are dewatered by vacuum filtration. Subsequently, all of the thickener effluent is recycled to the process, with the result that no process wastewater pollutants are discharged.

NSPS for the Wet Air Pollution Control System Segments

A. NSPS Alternative No. 1

The first NSPS alternative treatment system uses the BPT model and BAT Alternative No. 1 treatment systems discussed in Sections IX and X. The initial treatment step involves the gravity sedimentation of the process wastewaters in a thickener. Coagulant aid is added at the thickener inlet to enhance suspended solids removal. Sludges generated in the treatment process are dewatered by vacuum filtration. Most of the thickener effluent is recycled to the process, while a blowdown is delivered to a filter. In the EAF wet segment, the filter effluent is discharged, while in the BOF wet segments acid is added to the filter effluent (as required) to adjust the pH of these typically alkaline wastewaters to the neutral range (6.0 to 9.0) prior to discharge.

B. NSPS Alternative No. 2

This alternative treatment system includes the components of the BPT model and BAT Alternative No. 2 treatment systems. This alternative is similar to the system described above, however, lime addition and gravity sedimentation are incorporated prior to the filtration component noted in the first alternative. As discussed in Section X, lime addition serves to reduce toxic metal and fluoride effluent levels. Gravity sedimentation of the process wastewaters in this instance is accomplished in an inclined plate separator (as discussed in Section X).

C. NSPS Alternative No. 3

This alternative treatment system includes the BPT model and BAT Alternative No. 3 treatment systems. The third NSPS alternative treatment system is similar to the first NSPS alternative treatment system with the exception that sulfide precipitation is incorporated prior to filtration. Sulfide precipitation is incorporated for the purpose of providing additional toxic metal pollutant removals (refer to the discussion in Section X).

The NSPS alternative treatment systems described above are depicted in Figures XII-1 and XII-2. As NSPS treatment for the semi-wet air pollution control system segments provides for the recycle of all wastewaters, the proposed effluent standards for these segments are no discharge of process wastewater pollutants. The effluent standards for the wet air pollution control system segments are presented in Table XII-1. Cost data for the NSPS alternative treatment systems are presented in Tables VIII-38 through VIII-42.

Rationale for Selection of NSPS

The NSPS alternative treatment systems for the various segments of the steelmaking subdivisions are similar to the BPT model and BAT alternative treatment systems described in Sections IX and X. Therefore, the rationale presented in these sections is also applicable to new sources and is not repeated.

The NSPS alternative treatment systems for the wet air pollution control system segments are addressed below. The same considerations also apply to the semi-wet segment treatment systems.

Treatment Technologies

The use of gravity sedimentation, lime addition, filtration, and sulfide precipitation treatment technologies in the wet air pollution control system segments have been previously documented in Section X. These technologies are either demonstrated within this subcategory or, if not used within this subcategory, have been transferred from other subcategories or industries on the basis of demonstrated treatment capabilities. In light of the above factors, the recommended treatment technologies are reliable and demonstrated and, subsequently, are applicable for NSPS.

The resulting effluent wastewater quality for the NSPS alternative treatment systems of the wet air pollution control system segments are presented in Table XII-1. As noted in Sections X and XI, the critical pollutants and effluent levels were based upon the demonstrated capabilities of the various wastewater treatment technologies. The pollutants listed on this table include only those pollutants limited at BAT and NSPS (refer to Section X for a review of the factors considered in selecting these pollutants).

The treatment components used in the alternative treatment systems for the semi-wet air pollution control system segments have been documented in Sections VII and IX. As these technologies are demonstrated within these segments, the recommended treatment technologies are reliable and demonstrated and, subsequently, are applicable for NSPS. As noted previously, the NSPS level of treatment in these segments includes no discharge of process wastewater pollutants to a receiving stream.

Flows

The applied and effluent flows (or, in the case of the semi-wet segments, no effluent flow) developed for the proposed BPT and BAT limitations (refer to Sections IX and X) are applicable to the various NSPS treatment systems as well. Plants within each segment have not only demonstrated the ability to reduce effluent flows to the levels incorporated in the NSPS treatment systems, but have also demonstrated the recycle rates defined by the treatment model applied and discharge flow rates.

Selection of an NSPS Alternative

The proposed NSPS for the semi-wet air pollution control system segments are based upon the BPT model treatment system, (i.e., no discharge of process wastewater pollutants to navigable waters).

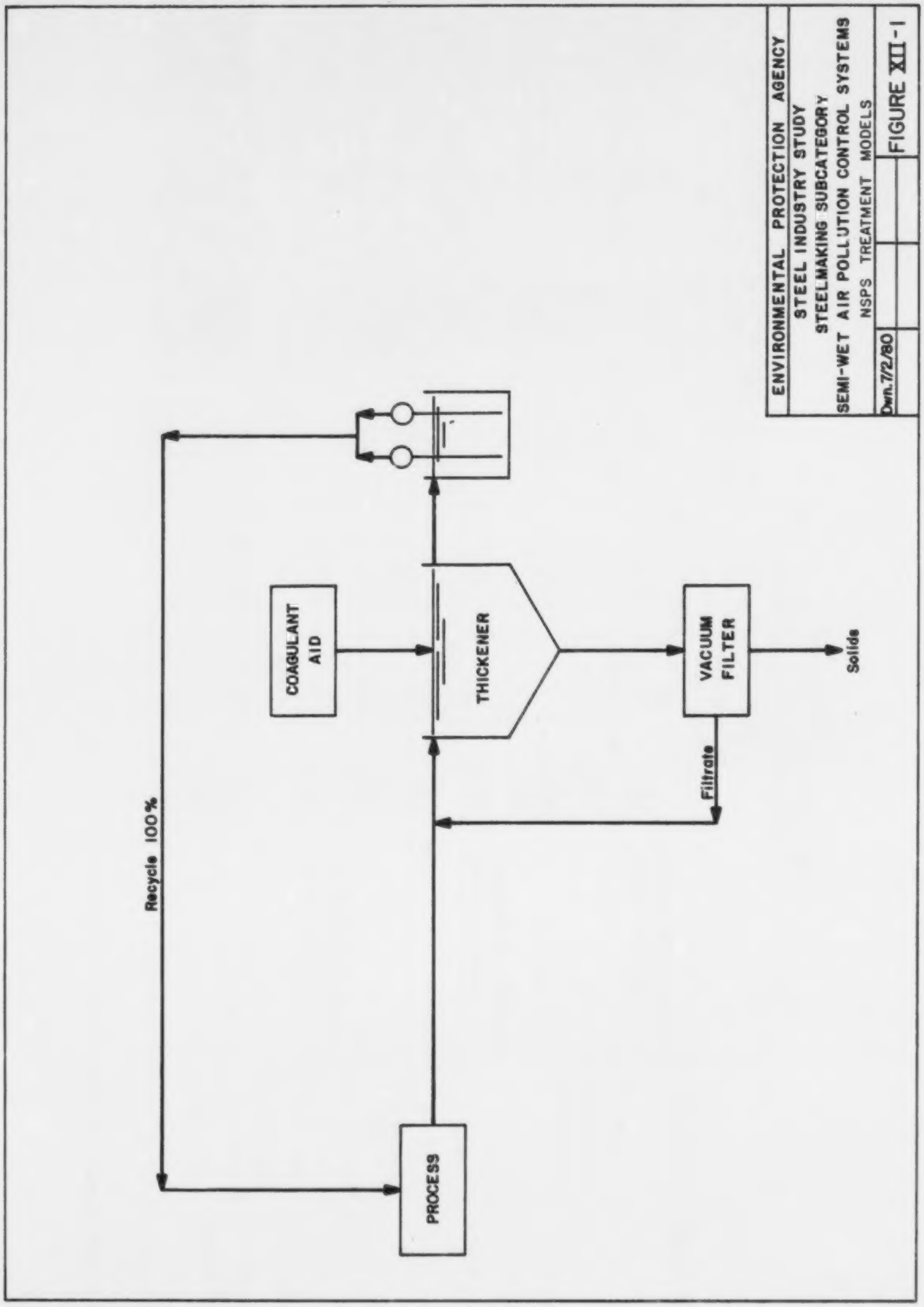
With regard to the wet air pollution control system segments, the Agency selected NSPS Alternatives No. 2 as the model treatment systems upon which the proposed NSPS for the BOF and EAF wet segments are based. These alternatives were selected for the reasons noted in the discussion in Section X pertaining to the selection of a BAT alternative.

The proposed NSPS are presented in Table XII-1 in the column for the second alternative.

TABLE XII-1
NSPS EFFLUENT LEVELS AND LOADS
STEELMAKING SUBCATEGORY

SUBDIVISION	SEGMENT			NSPS ALTERNATIVE Nº 1		NSPS ALTERNATIVE Nº 2		NSPS ALTERNATIVE Nº 3	
				CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of Product)	CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of Product)	CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of Product)
BASIC OXYGEN FURNACE	WET-SUPPRESSED COMBUSTION	DISCHARGE FLOW (gal/ton)		50	——	50	——	50	——
		TOTAL SUSPENDED SOLIDS	AVE.	15	0.00313	15	0.00313	15	0.00313
			MAX.	40	0.00834	40	0.00834	40	0.00834
		pH		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0	
		CHROMIUM	AVE.	0.10	0.000021	0.10	0.000021	0.10	0.000021
			MAX.	0.30	0.000063	0.30	0.000063	0.30	0.000063
		LEAD	AVE.	2.00	0.000417	0.30	0.000063	0.15	0.000031
			MAX.	6.00	0.00125	0.90	0.000188	0.45	0.000094
		ZINC	AVE.	0.90	0.000188	0.30	0.000063	0.25	0.000052
			MAX.	2.70	0.000563	0.90	0.000188	0.75	0.000156
	WET-OPEN COMBUSTION	DISCHARGE FLOW (gal/ton)		65	——	65	——	65	——
		TOTAL SUSPENDED SOLIDS	AVE.	15	0.00407	15	0.00407	15	0.00407
			MAX.	40	0.0108	40	0.0108	40	0.0108
		pH		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0	
		CHROMIUM	AVE.	0.80	0.000217	0.25	0.000068	0.10	0.000027
			MAX.	2.40	0.000651	0.75	0.000203	0.30	0.000081
		LEAD	AVE.	0.30	0.000081	0.25	0.000068	0.15	0.000041
			MAX.	0.90	0.000244	0.75	0.000203	0.45	0.000122
		ZINC	AVE.	0.90	0.000244	0.30	0.000081	0.25	0.000068
			MAX.	2.70	0.000732	0.90	0.000244	0.75	0.000203
ELECTRIC ARC FURNACE	WET AIR POLLUTION CONTROL SYSTEMS	DISCHARGE FLOW (gal/ton)		50	——	50	——	50	——
		TOTAL SUSPENDED SOLIDS	AVE	15	0.00313	15	0.00313	15	0.00313
			MAX.	40	0.00834	40	0.00834	40	0.00834
		pH		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0	
		CHROMIUM	AVE.	0.40	0.000083	0.15	0.000031	0.10	0.000021
			MAX.	1.20	0.000250	0.45	0.000094	0.30	0.000063
		LEAD	AVE.	1.50	0.000313	0.30	0.000063	0.15	0.000031
			MAX.	4.50	0.000938	0.90	0.000188	0.45	0.000094
		ZINC	AVE.	25	0.00521	0.35	0.000073	0.25	0.000052
			MAX.	75	0.0156	1.05	0.000219	0.75	0.000156

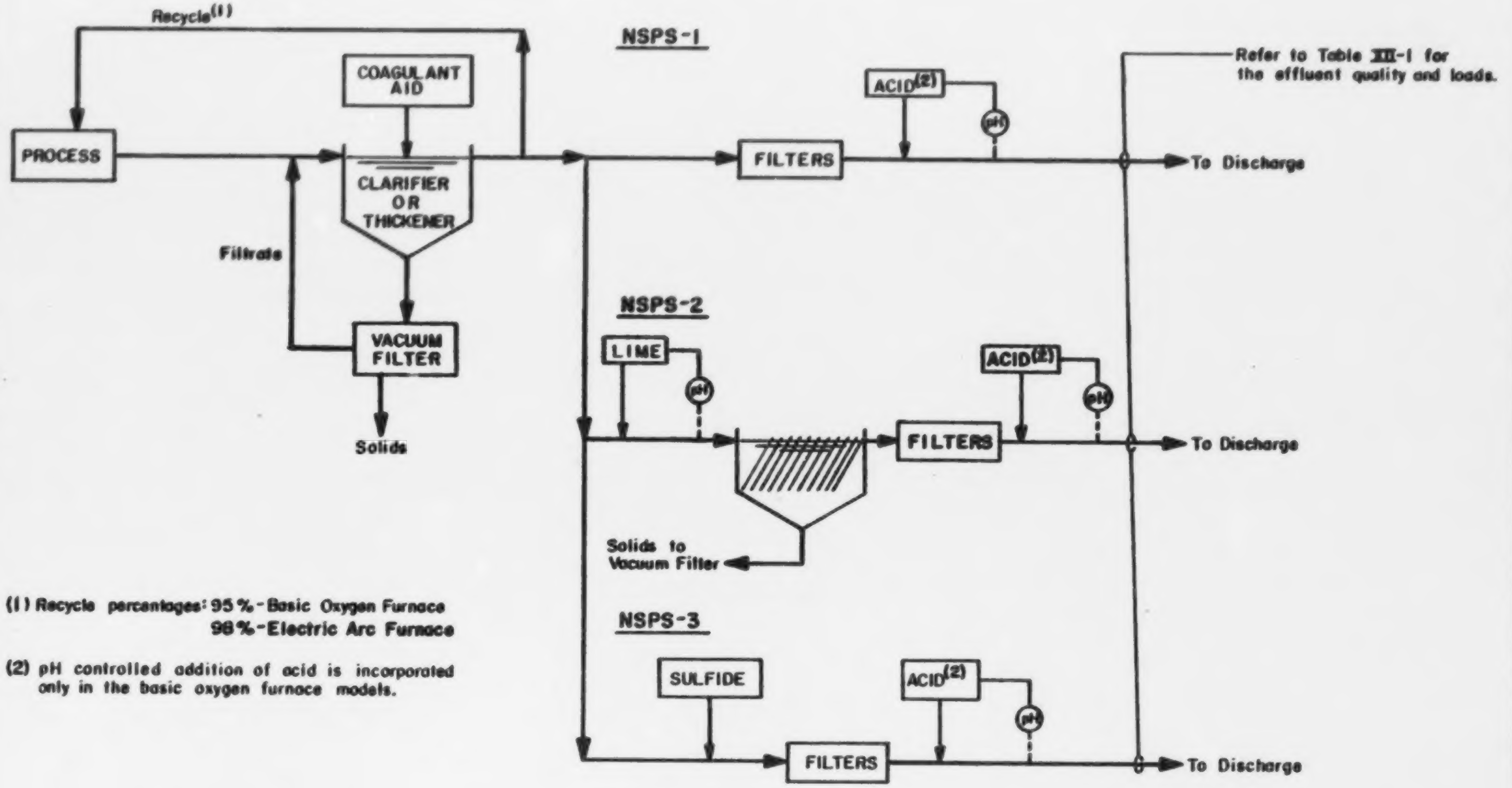
Proposed NSPS are based upon NSPS Alternative No. 2 (the selected alternative).


PROCESS
Recycle 100%
COAGULANT AID
THICKENER
VACUUM FILTER
Solids
Filtrate

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
STEELMAKING SUBCATEGORY
SEMI-WET AIR POLLUTION CONTROL SYSTEMS
NSPS TREATMENT MODELS

Dwn. 7/2/80

FIGURE XII-1


Recycle(1)
NSPS-1
COAGULANT AID
PROCESS
CLARIFIER OR THICKENER
Filtrate
VACUUM FILTER
Solids
FILTERS
ACID(2)
pH
Refer to Table XII-1 for the effluent quality and loads.
To Discharge
NSPS-2
LIME
pH
FILTERS
ACID(2)
pH
To Discharge
Solids to Vacuum Filter
NSPS-3
SULFIDE
FILTERS
ACID(2)
pH
To Discharge

(1) Recycle percentages: 95%-Basic Oxygen Furnace
98%-Electric Arc Furnace

(2) pH controlled addition of acid is incorporated only in the basic oxygen furnace models.

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
STEELMAKING SUBCATEGORY
WET AIR POLLUTION CONTROL SYSTEMS
NSPS TREATMENT MODELS
Dwn. 6/26/80
FIGURE XII-2

STEELMAKING SUBCATEGORY

SECTION XIII

PRETREATMENT STANDARDS FOR DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS

Introduction

This section discusses the control and treatment technologies available for steelmaking operations which discharge wastewaters to publicly owned treatment works (POTWs). Only one of the plants in the wet segments of the steelmaking subdivisions discharges process wastewaters to a POTW. Separate consideration has been given to the pretreatment of wet subdivision process wastewaters from new sources and from existing sources.

The general pretreatment and categorical pretreatment standards applying to steelmaking operations are discussed below.

General Pretreatment Standards

For detailed information on Pretreatment Standards refer to 43 FR 27736-27773, "General Pretreatment Regulations for Existing and New Sources of Pollution," (June 26, 1978). In particular, 40 CFR Part 403 describes national standards (prohibited and categorical standards), revision of categorical standards through removal allowances, and POTW pretreatment programs.

In establishing pretreatment standards for steelmaking operations, the Agency gave primary consideration to objectives and requirements of the General Pretreatment Regulations. The General Pretreatment Regulations set forth general discharge prohibitions that apply to all non-domestic users of a POTW to prevent pass-through of pollutants, interference with the operation of a POTW, and municipal sludge contamination. The regulations also establish administrative mechanisms to ensure application and enforcement of prohibited discharge limits and categorical pretreatment standards. In addition, the Regulations contain provisions relating directly to the determination of and reporting on Pretreatment Standards.

POTWs are usually not designed to treat the toxic pollutants present in steelmaking process wastewaters. Instead, POTWs are designed to treat biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform bacteria, and pH. Whatever removal obtained by POTWs for toxic pollutants is incidental to the POTW's main function of conventional pollutant treatment. POTWs have, historically, accepted large amounts of many pollutants well above their capacity to treat them adequately. As the issue of municipal sludge use has become more important, pretreatment standards must address toxic and nonconventional pollutant removal, rather than transfer these pollutants to POTWs where many pollutants concentrate in the sludges.

Pretreatment standards for total suspended solids, oil and grease, and pH are not proposed because these pollutants, at the levels found after pretreatment in this subcategory, are compatible with POTW operations and can be effectively treated at POTWs.

Due to the presence of toxic pollutants in wastewaters from steelmaking operations, pretreatment must be provided to ensure that these pollutants do not interfere with, pass through, or otherwise be incompatible with POTW operations or damage the treatment facilities. The following discussions identify the pretreatment pollutant removals, the rationale for these technologies, and, finally, the development of pretreatment model upon which the proposed categorical PSES and PSNS are based.

Identification of Pretreatment

The model pretreatment systems (PSES and PSNS) for semi-wet systems are identical to those for BPT. Hence, the proposed PSES and PSNS provide for no discharge of process wastewater pollutants to POTWs. Semi-wet systems will not exert any impacts (from toxic metals, etc.) on POTWs.

The pretreatment systems developed for both New and Existing Sources in the wet segments of the BOF, open hearth, and EAF subdivisions are identical to the BPT model and BAT Alternative No. 2 treatment systems for these segments (refer to Section IX and X). As these treatment systems are identical to the NSPS treatment model, the need for separate New Source and Existing Source Pretreatment Standards is obviated.

Only those treatment systems selected for use as the basis for the proposed BAT effluent limitations and NSPS were retained for use as pretreatment systems.

The primary goal of the pretreatment systems is the removal of toxic metal pollutants. In the initial steps of the pretreatment model systems for all of the wet segments, that substantial portion of the toxic metal pollutants load entrained in the suspended solids is removed by gravity sedimentation in a thickener. A coagulant aid is added at the thickener inlet to enhance solids (and, in turn, toxic metals) removal performance. The sludges removed from the thickener are dewatered by vacuum filtration. Most of the thickener effluent is then recycled while a small system blowdown undergoes additional pretreatment. The recycle system blowdown then undergoes treatment consisting of lime precipitation, sedimentation (in an inclined plate separator), and filtration. The goal of this system is to reduce toxic metals effluent levels and loads. In the case of BOF operations, acid is added to the filter effluent to lower the pH of the typically alkaline wastewaters to the neutral range.

Figure XIII-1 illustrates the pretreatment systems described above. Table XIII-1 presents the proposed PSES and PSNS. Refer to Tables VIII-40 through VIII-43 for pretreatment model cost information.

Rationale for the Selection of Pretreatment Technologies

The effluent flows and, in turn, the recycle components incorporated in the pretreatment systems described above have been reviewed in Section X. Recycle is necessary in these pretreatment systems in order to minimize the hydraulic impact of process wastewater discharges to a POTW. Excessive flows to a POTW must be restricted not only for reasons of physical limitations (i.e., hydraulic constraints), but also for reasons of process limitations (the "washing out" of the biological treatment media). The pretreatment system effluent flows are identical to those of the BAT and NSPS models.

Sedimentation, recycle, lime precipitation, further sedimentation, and filtration are included in the pretreatment systems in order to reduce toxic metal pollutant levels and loads. Pretreatment standards must be provided for toxic metal pollutants as they can adversely affect a POTW in the following ways: (1) inhibit the POTW treatment process, (2) pass through the POTW during treatment, and, (3) contaminate the POTW sludges.

Various studies[3] have demonstrated that the toxic metal pollutants found in wet air pollution control system wastewaters inhibit the biological treatment process when found at levels typical of these steelmaking operations. Inclusion of the above technologies in the pretreatment systems will ensure that the toxic metal pollutants present in the wastewater discharges of these segments will not adversely affect the treatment process.

Other studies[4] involving the electroplating industry (with similar levels of the same toxic metals) indicated that from fifty percent to ninety percent of the toxic metal pollutants entering a POTW will pass through the system. The possibility therefore exists that a POTW could discharge undesirable levels of toxic metal pollutants when accepting industrial process wastewaters.

The toxic metal pollutants which do not pass through a POTW are concentrated in the POTW sludges. Generally, land application is the most advantageous, yet least expensive, method of POTW sludge disposal as the sludge can be used to replace soil nutrients. However, excessive amounts of toxic metal pollutants in the sludges could inhibit plant growth, thus rendering the sludge unfit for use as a soil nutrient supplement. In addition, these metals could enter either the plant or animal food chain or could leach into the groundwater. For the above reasons, the Agency believes that the control of toxic metal pollutant discharges to a POTW is essential. The Agency did not develop pretreatment standards for fluoride in the steelmaking subcategory as fluoride, in the amounts present in steelmaking wastewaters, will not adversely affect POTW operations.

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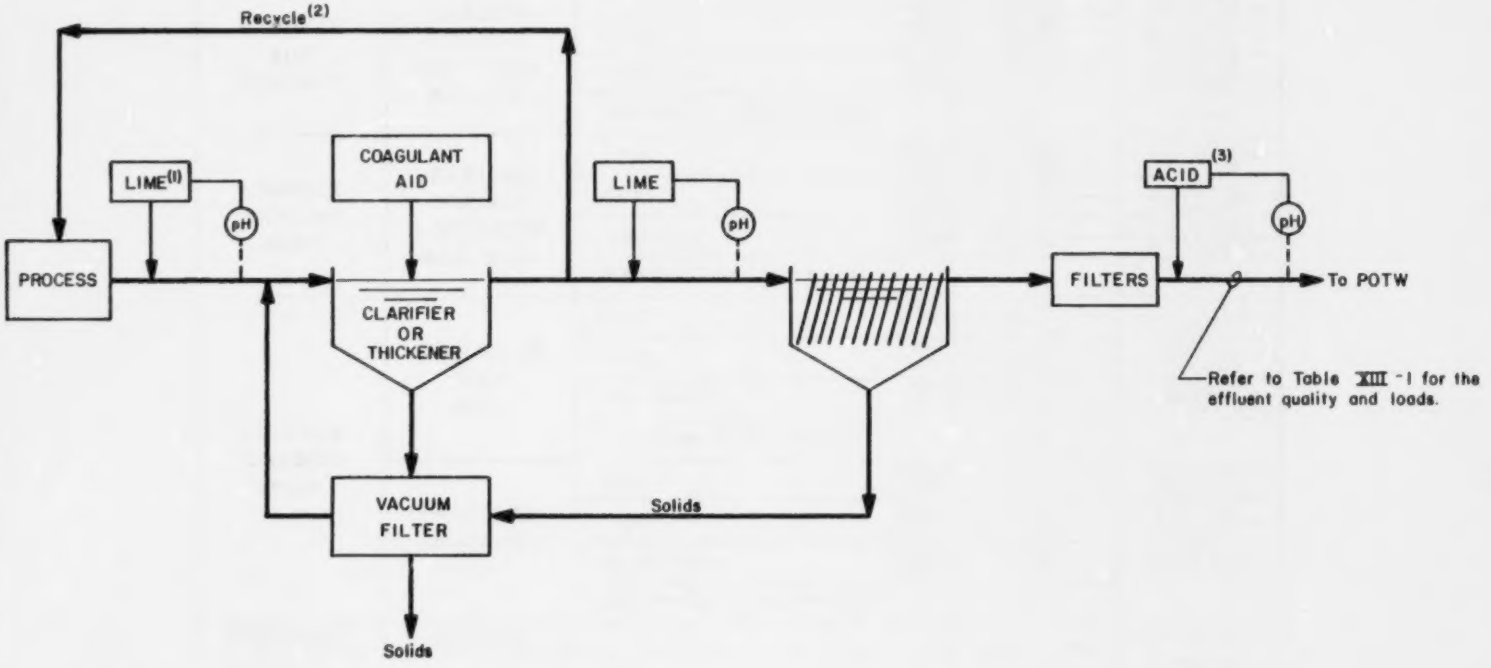
[3] EPA-430/9-76-017a, Construction Grants Program Information; Federal Guidelines, State and Local Pretreatment Programs.

[4] Federal Register; Friday, September 7, 1979; Part IV, Environmental Protection Agency; Effluent Guidelines and Standards; Electroplating Point Source Category; Pretreatment Standards for Existing Sources - Pages 52597-52601.

TABLE XIII-I
PRETREATMENT EFFLUENT LEVELS AND LOADS
STEELMAKING SUBCATEGORY

SUBDIVISION	SEGMENT			CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of product)
BASIC OXYGEN FURNACE	WET-SUPPRESSED COMBUSTION	DISCHARGE FLOW (gal/ton)		50	——
		CHROMIUM	Ave.	0.10	0.000021
			Max.	0.30	0.000063
		LEAD	Ave.	0.30	0.000063
			Max.	0.90	0.000188
		ZINC	Ave.	0.30	0.000063
			Max.	0.90	0.000188
	WET-OPEN COMBUSTION	DISCHARGE FLOW (gal/ton)		65	——
		CHROMIUM	Ave.	0.25	0.000068
			Max.	0.75	0.000203
		LEAD	Ave.	0.25	0.000068
			Max.	0.75	0.000203
		ZINC	Ave.	0.30	0.000081
			Max.	0.90	0.000244
OPEN HEARTH FURNACE	WET AIR POLLUTION CONTROL SYSTEMS	DISCHARGE FLOW (gal/ton)		110	——
		CHROMIUM	Ave.	0.10	0.000046
			Max.	0.30	0.000138
		LEAD	Ave.	0.15	0.000069
			Max.	0.45	0.000206
		ZINC	Ave.	0.30	0.000138
			Max.	0.90	0.000413
ELECTRIC ARC FURNACE	WET AIR POLLUTION CONTROL SYSTEMS	DISCHARGE FLOW (gal/ton)		50	——
		CHROMIUM	Ave.	0.15	0.000031
			Max.	0.45	0.000094
		LEAD	Ave.	0.30	0.000063
			Max.	0.90	0.000188
		ZINC	Ave.	0.35	0.000073
			Max.	1.05	0.000219


Recycle(2)
LIME(1)
pH
COAGULANT AID
LIME
pH
ACID(3)
pH
PROCESS
CLARIFIER OR THICKENER
FILTERS
To POTW
Refer to Table XIII -1 for the effluent quality and loads.
VACUUM FILTER
Solids
Solids

(1) pH controlled addition of lime is incorporated only in the open hearth model.

(2) Recycle rates: 95% - Basic Oxygen Furnace
94% - Open Hearth
98% - Electric Arc Furnace

(3) pH controlled addition of acid is incorporated only in the basic oxygen furnace model.

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
STEELMAKING SUBCATEGORY
PRETREATMENT MODELS

Dwn. 7/8/80

FIGURE XIII-1

VACUUM DEGASSING SUBCATEGORY

SECTION I

PREFACE

The USEPA is proposing effluent limitations guidelines and standards for the steel industry. The proposed regulation contains effluent limitations guidelines for best practicable control technology currently available (BPT), best conventional pollutant control technology (BCT), and best available technology economically achievable (BAT) as well as pretreatment standards for new and existing sources (PSNS and PSES) and new source performance standards (NSPS), under Sections 301, 304, 306, 307, and 501 of the Clean Water Act.

This part of the Development Document highlights the technical aspects of EPA's study of the Vacuum Degassing Subcategory of the Iron and Steel Industry. Volume I of the Development Document discusses issues pertaining to the industry in general, while other volumes relate to the remaining subcategories of the industry.

VACUUM DEGASSING SUBCATEGORY

SECTION II

CONCLUSIONS

This report highlights the technical aspects of EPA's study of the Vacuum Degassing Subcategory of the Iron and Steel Manufacturing Category.

Based on this current study and a review of previous studies, EPA has reached the following conclusions.

1. The Agency has decided not to subdivide the vacuum degassing subcategory based upon the type of steel processed, the type of degassing system employed, wastewater characteristics, size, age, or geographical location.

2. The proposed BPT effluent limitations are identical to those originally promulgated in 1974. The proposed BPT effluent limitations regulate pH and the discharge of total suspended solids (TSS). Sampled plant and long-term analytical data substantiate the appropriateness of the originally promulgated effluent limitations for this subcategory.

3. Several responses from the industry to EPA questionnaires indicate that recycle components in use at vacuum degassing plants present no scaling, fouling, or plugging problems.

4. Sampling and analysis of vacuum degassing process wastewaters revealed significant concentrations of five toxic metal pollutants. Discharges of these toxic pollutants can be reduced by available economically achievable technologies. A summary of the pollutant discharges at the proposed BPT and BAT levels of treatment are shown below.

	Effluent Discharges (Tons/Year)		
	Raw Waste	Proposed BPT	Proposed BAT
Flow, MGD	57	1	1
TSS	6950	78	23
Toxic Metals	976	1.8	0.7

5. Based upon facilities in place as of January 1, 1978, the Agency estimates the following costs are required to achieve the proposed BPT and BAT effluent limitations for the vacuum degassing subcategory.

	Costs (Millions of July 1, 1978 Dollars)			
	Investment Costs			Annual
	Total	In-Place	Required	Costs
BPT	30.3	9.9	20.4	7.7
BAT	1.6	0.6	1.0	0.2

NOTE: PSES costs are included in BPT and BAT costs.

6. The Agency evaluated the "cost reasonableness" of controlling the conventional pollutant, TSS, and concludes that control costs based upon the BCT model treatment system are greater than the costs experienced by publicly owned treatment works (POTWs). Hence, the proposed BPT limitation for suspended solids is also proposed as the BCT effluent limitation for suspended solids.

7. Proposed NSPS for vacuum degassing operations are equivalent to the proposed BAT effluent limitations and are based on the same model treatment systems.

8. EPA has proposed pretreatment standards for new and existing sources (PSNS and PSES) which limit the amounts of toxic pollutants which can be discharged to POTWs. These standards, which are based upon the filtration of a treatment and recycle system effluent, are intended to minimize the impact of those pollutants (the toxic metals) which interfere with, pass through, or otherwise are incompatible with POTW operations.

9. With regard to the "remand issues," the Agency concludes that:

   a. The incorporation of cooling towers in the BPT model treatment system (retained in the BAT model treatment system) will result in a minor increase in water consumption. It is estimated that implementation of the above treatment technologies will result in the consumption of an additional 0.13 MGD of water for the subcategory. However, as this total represents only 0.23% of the estimated total water application in this subcategory, the Agency considers the impact of the consumptive use of water to be minimal, in particular, since the cooling components allow higher recycle rates. In turn, higher recycle rates serve to reduce the total volume of water used in and discharged from the process, thereby minimizing the discharge of pollutants. It must also be recognized that water condensed from the steam used in the degassing process will replace at least a portion of the water consumed in the treatment process.

   b. The estimated cost to install the model treatment systems is not significantly affected whether the system is an "initial fit" or a "retrofit". Moreover, the ability to implement various wastewater treatment practices at a plant is not affected by the plant's age. The comparison of costs reported by the visited plants and in the D-DCPs with the

Agency's estimated expenditures (based on the application of model costs) of these plants, indicates that the estimated subcategory treatment costs are sufficiently generous to cover site-specific and other incidental costs.

c. The following references pertain to the remand concerning the TSS levels used in developing the original BAT limitations and NSPS. Not only do the BAT and NSPS alternative treatment systems presented in this report differ substantially from the treatment model presented in the 1974 document, but the suspended solids levels, upon which the proposed effluent limitations are based, now represent an analysis of additional extensive analytical data. Therefore, the suspended solids levels incorporated in the treatment models are applicable and justified. It should be noted that suspended solids effluent limitations are not established at BAT, but are now proposed at BCT.

10. The Agency found vacuum degassing operations which achieve zero discharge. The Agency is soliciting comments on whether zero discharge limitations should be promulgated at the BAT, BCT, NSPS, PSES, and PSNS levels based upon the demonstrated performance of plants in this subcategory. These plants are currently achieving zero discharge with BPT model treatment system components. Hence, no additional costs beyond those required for BPT would be necessary to achieve zero discharge.

11. Table II-1 presents the treatment model flow and effluent quality data used to develop the proposed BPT effluent limitations for the vacuum degassing subcategory, and Table II-2 presents these proposed limitations. Table II-3 presents the treatment model flow and effluent quality data used to develop the proposed BAT and BCT effluent limitations and the proposed NSPS, PSES, and PSNS for the vacuum degassing subcategory; Table II-4 presents these proposed limitations and standards.

TABLE II-1

BPT TREATMENT MODEL FLOW AND EFFLUENT QUALITY VACUUM DEGASSING SUBCATEGORY

Pollutant	Monthly Average Concentration (mg/l)(1)
Flow, gal/ton	25
TSS	50
pH, Units	6.0 to 9.0

---

(1): Daily maximum concentration is three times the above monthly average concentration.

TABLE II-2

PROPOSED BPT EFFLUENT LIMITATIONS VACUUM DEGASSING SUBCATEGORY

Pollutant	Effluent Limitations (kg/kkg of Product) (1)
TSS	0.0052
pH, Units	Within the range of 6.0 to 9.0

---

(1): Daily maximum effluent limitations are three times the above monthly average effluent limitations.

TABLE II-3

TREATMENT MODEL FLOWS AND EFFLUENT QUALITY VACUUM DEGASSING SUBCATEGORY

		Monthly Average Concentrations (mg/l)(1)				
	Pollutant	BAT	BCT	NSPS	PSES	PSNS
	Flow, gal/ton	25	25	25	25	25
	TSS	-	50	15	-	-
119	Chromium (Total)	0.10	-	0.10	0.10	0.10
122	Lead	0.10	-	0.10	0.10	0.10
128	Zinc	0.10	-	0.10	0.10	0.10
	pH, Units	-	6.0 to 9.0	6.0 to 9.0	-	-

---

(1): Daily maximum concentrations are the above monthly average concentrations multiplied by the following factors:

Pollutants	Factors
TSS (at the BCT level), Chromium, Lead, Zinc	3.0
TSS (at the NSPS level)	2.67

TABLE II-4

PROPOSED EFFLUENT LIMITATIONS AND STANDARDS VACUUM DEGASSING SUBCATEGORY

		Effluent Limitations and Standards (kg/kkg of Product)(1)				
	Pollutant	BAT	BCT	NSPS	PSES	PSNS
	TSS	-	521	156	-	-
119	Chromium (Total)	1.04	-	1.04	1.04	1.04
122	Lead	1.04	-	1.04	1.04	1.04
128	Zinc	1.04	-	1.04	1.04	1.04
	pH, Units	-	Within the range 6.0 to 9.0		-	-

---

(1): The proposed limitations and standards have been multiplied by 10^5 to obtain the values presented in this table. Daily maximum limitations and standards are the above monthly average limitations and standards multiplied by the following factors:

Pollutants	Factors
TSS (at the BCT level), Chromium, Lead, Zinc	3.0
TSS (for NSPS)	2.67

VACUUM DEGASSING SUBCATEGORY

SECTION III

INTRODUCTION

General Discussion

Vacuum degassing is the process of removing gases (principally hydrogen, oxygen, and nitrogen) from molten steel under a vacuum to produce steels of high metallurgical standards. While this technique has been used for many years, widespread application of the vacuum degassing process to large tonnages of carbon and low alloy steels was not possible until recent years when large capacity vacuum degassing units were developed. The application of vacuum degassing to tonnage steel production in the United States began in the mid-1950's.

Steam jet ejectors are commonly used to produce the vacuum for the large tonnage vacuum degassing units. Subsequently, barometric condensers (intercondensers) are used to condense the steam used in the ejectors. After cooling water is sprayed into the intercondensers, the heated waters and condensed steam are discharged to a hot well. During the application of the vacuum to the molten steel, certain elements, which have a relatively higher vapor pressure (such as manganese and zinc), are volatilized and removed with the gases. These gases and vaporized elements pass through the steam jet ejectors into the intercondensers thus contaminating the cooling waters.

This report reviews wastewater characteristics and treatability, alternative treatment systems, and the proposed effluent limitations which were considered by the Agency for the vacuum degassing subcategory. Figures III-1 and III-2 illustrate the eight different degassing processes currently used in the United States. The Agency originally promulgated BPT limitations for the Vacuum Degassing subcategory in 1974. The Agency reviewed these limitations and developed alternative limitations and standards in light of the court remanded issues, the 1977 Amendments to the Clean Water Act, and the additional data received since the original promulgation. The primary sources of the additional data are sampling data and industry responses to the basic and detailed questionnaires.

The Agency obtained valuable process information and wastewater quality data through sampling visits at six vacuum degassing plants. These visits were conducted during the original guidelines and the subsequent toxic pollutant surveys. Four plants were sampled during the original guidelines survey. Of these four, one has since changed from vacuum degassing to Argon Oxygen Decarburization. The Agency sampled three degassing plants during the recent toxic pollutant survey; one of which was also sampled during the original guidelines survey. The plants which were sampled during either survey are listed in Table III-1.

Data Collection Activities

In 1976, basic questionnaires (DCPs) were sent to every vacuum degassing operation in the United States. In response, the Agency received information regarding applied and discharge flow rates, existing treatment systems, plant capacities and modes of operation for 34 vacuum degassing plants with 37 individual degassing units. Table III-2 presents an inventory of all vacuum degassing plants and summarizes the data obtained from the industry.

After receiving and reviewing the DCP responses, the Agency sent detailed questionnaires (D-DCPs) to selected degassing plants to obtain information on long-term effluent quality, treatment costs, and the vacuum degassing process itself. Six degassing plants provided D-DCP responses. Table III-3 summarizes the data base for this report as derived from the above mentioned sources of information.

Vacuum degassing limitations were originally promulgated on the basis of the steam intercondenser cooling water discharges. Based upon an examination of the additional data received since that time, the Agency has concluded that no further subdivision of this subcategory is appropriate.

Description of Vacuum Degassing Operations

Vacuum degassing is the process in which molten steel is subjected to a vacuum in order to remove gases from the molten steel. The gases hydrogen, oxygen, and nitrogen can impart detrimental qualities to the finished steel product if not removed. Hydrogen, in particular, can cause flaking and embrittlement of steel. Oxygen and nitrogen, when in combination with other elements, can remain in the steel as unwanted inclusions.

The hydrogen gas is removed when the partial pressure of hydrogen above the molten bath is reduced. Carbon and oxygen are removed from steel by reaction with one another as the pressure above the molten bath is reduced. The carbon monoxide generated by this reaction is released, thus reducing the carbon and oxygen content of the molten steel. There are presently seven types of vacuum and one type of nonvacuum degassing processes in use in the United States. The nonvacuum process is called Argon degassing. Descriptions of the degassing processes follow:

1. Vacuum Ingot Degassing is the method in which an ingot mold is stationed inside an enclosed vacuum chamber. The hot metal ladle is then positioned on top of the vacuum chamber. The hot metal is exposed to the vacuum as it travels through a small opening in the vacuum chamber roof to the ingot mold. This method is used for producing ingots for large forgings.

2. Vacuum Stream Degassing is a method similar to that of ingot degassing. However, instead of an ingot mold, an empty hot metal ladle is stationed inside the vacuum chamber. The hot metal ladle is mounted on top of the vacuum chamber and metal is poured through a small opening in the roof of the chamber.

3. Vacuum Tap Degassing involves pouring of the molten steel from the furnace into a tundish which is mounted upon the steel ladle. The ladle in this method is fitted with a cover and, thus, serves as the vacuum chamber.

The above three methods are known as stream degassing methods.

4. Vacuum Flush Degassing is the method in which the hot metal ladle is stationed in a vacuum chamber and an inert gas (flush gas), such as argon, is bubbled through the hot metal under reduced pressures. The bubbles of flush gas provide sites into which carbon monoxide, hydrogen and nitrogen gases can diffuse and be carried out of the molten metal.

5. Vacuum Lift Degassing, commonly identified as the D-H process, was developed by Dortmund-Horder Huttenunion AG of Germany. For this method, the molten steel is tapped into a teeming ladle which is then transferred to a degassing station consisting of a preheated refractory lined chamber equipped with a "snorkle" tube in the bottom. The chamber is lowered into the ladle of steel and then evacuated to a low pressure. The pressure differential between the low pressure within the chamber and atmospheric pressure acting upon the surface of the steel bath forces a column of molten steel into the snorkle tube and the chamber. The release of gases caused by the introduction of steel to a low pressure results in turbulence of the molten steel. By alternately raising and lowering the snorkle tube vacuum chamber, all of the molten steel is subjected to low pressure and any absorbed gases are released to the atmosphere. After appropriate alloying additions are made, the vacuum chamber is lifted and removed. The steel is then ready for casting or teeming of ingots. This particular method can accommodate large tonnages of steel.

6. Vacuum Circulation Flow Degassing, commonly referred to as the R-H process, was developed by Rheinstahl Huttenwerke HG and W.C. Heraeus GmbH of West Germany. The equipment consists of a vacuum chamber with two snorkle tubes which are immersed in the molten steel. Once the tubes are immersed, the vacuum valves are opened. Argon gas under pressure is introduced in one snorkle leg. As the gas injection creates a pressure differential, the molten steel rises in one tube of the vacuum chamber and flows down the other tube back to the ladle. The molten steel is continuously circulated until the desired level of gas removal is achieved. An alternative method involves the use of electromagnetic induction pumping to recirculate the molten steel through the snorkle tubes.

7. Vacuum Induction Degassing is a method of stationing the hot steel ladle in a vacuum chamber equipped with low frequency electric current induction coils which stir the molten metal. The hot metal circulates from the bottom to the top of the ladle, thus exposing the circulating hot metal to the vacuum.

8. Argon Degassing is a method of degassing which, instead of providing a vacuum, uses argon as an inert shielding gas. Argon is bubbled through the hot metal in a covered ladle. The argon displaces air from the hood atmosphere as carbon monoxide, hydrogen, and oxygen gases diffuse into the bubbles at rates influenced by the oxygen and carbon content of the steel. Typical argon requirements per ton of steel are about 40 cubic feet for a period of 12-23 minutes, depending upon the amount of molten steel treated. The argon degassing method is the most expensive of all degassing methods.

The vacuum degassing operation serves as an intermediate step in steelmaking. After the hot metal has been refined to steel in basic oxygen, electric arc, or open hearth furnaces, the molten steel is transferred to the vacuum degasser for further refining. Degassing is only performed when required by steel order specifications. Therefore, not all steel is degassed. After the molten steel is degassed, it is then transferred either to a continuous casting machine or is teemed into ingot molds.

The basic vacuum degassing equipment includes a method to develop a vacuum and to expose all of the molten steel to the vacuum.

There are two methods of developing the vacuum for degassing cycles. One method involves the use of vacuum pumps, which are generally used for smaller tonnage operations, or stream degassing. As no process wastewaters are generated in this type of vacuum degassing operation, no further discussion of these operations is presented in this report. The second method uses multiple stage steam jet ejectors. Four to six stages are normally used to develop the vacuum in the latter instance. Several barometric steam condensers, which use water as the cooling medium, are employed between ejector stages. The water from the condensers is discharged to a hot well through a barometric leg (a pipe which rises 32 feet above the hot well and is immersed for sealing in the hot well). Any of the gases emerging from the vacuum degassing operation are intermittently mixed with steam and water from the condensers.

Wastewater discharges occur when the waters, which are used to condense the steam, are contaminated with the gases and particulates carried with the steam that is used in the steam jet ejectors.

The selection of the degassing process is influenced by steel specifications, heat scheduling, plant layout limitations, and limitations in the steelmaking process to achieve given steel specifications. All degassing methods require a 5 to 30 minute degassing cycle. Generally the large tonnage producers use the R-H or D-H processes. The faster process, stream degassing, has lower production costs because capital investment is lower per ton of design capacity.

TABLE III-1

SUMMARY OF SAMPLED PLANTS VACUUM DEGASSING

Sample Code	Plant Reference Code	Steel Type
E*	0020B	Specialty
062	0496	Carbon
AC**	0584F	Carbon
065**	0584F	Carbon
068	0684H	Specialty
G	0856R	NR
AD	0868B	Carbon

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* : This plant has changed from vacuum degassing to argon oxygen decarburization since it was sampled.

**: This plant was sampled during both the original guidelines and toxic pollutant surveys. However, the data gathered during the toxic pollutant survey is used in preference to that obtained during the original survey, as the toxic survey data is more recent and thus considered to be more representative of current practices.

NR: Not reported.

TABLE III-2

GENERAL SUMMARY TABLE VACUUM DEGASSING

Plant Code	Type of Unit	Type of Steel	Plant Age	Production (Tons/Day) Rated Capacity	Production (Tons/Day) 1976 Production	Flows (Gal/Ton) Applied Flow	Flows (Gal/Ton) Discharge Flow	Treatment Components Process Treatment	Treatment Components Central Treatment	Operating Mode	Discharge Mode
0020B(1)	**	**	**	**	**	**	**	**	**	**	**
0060	R-H	CS-75,HSLA-25	1971	4500	1499	272	272	None	PSP,FLL, FLOl,CL	RET100	Indirect Discharge
0060D	D-H	ES-[illegible]3,CS-13.5 HSLA-12,SS-10	1969	3000	1758	432	82	CL,PSP	None	RTP81 BD19	Direct
0060F	R-H	HSLA-100	1970	1100	380	-	-	CT	SL	RET(UNK) RTP(UNK) BD(UNK)	Direct
*0060J	-	HSLA-40,ES-31 CS-18,SS-6,AT-5	1965	120	31	-	-	-	-	-	-
0088A	Ladle Degassing	Other-70,AT-29 CS-1	1963	239(2)	202(2)	[743]	[10.6]	None	FLP,ML, CL,SS,VF	RTP98.6 RET1.4	Direct
0088A	Ladle Degassing	Other-70,AT-29 CS-1	1968	239(2)	202(2)	[743]	[10.6]	None	FLP,ML, CL,SS,VF	RTP98.6 RET1.4	Direct
*0112	-	HSLA-97,SS-3	1957	450	326	-	-	-	-	-	-
*0112B	-	CS-85,HSLA-15	1973	1860	517	-	-	-	-	-	-
*0156A	-	**	**	**	**	-	-	-	-	-	-
*0168	-	HSLA-51,CS-25, AT-14,SS-5, Other-5	1968	450	361	-	-	-	-	-	-
*0240A	-	Other-70,CS-25, AT-5	1962	1100	872	-	-	-	-	-	-
0248B	D-H	AT-55,CS-40, HSLA-5	1969	1700	589	420	0	-	-	RTP100	Zero Discharge
*0424A	-	HSLA-60,CS-40	1969	800	63	-	-	-	-	-	-
0436	Stream Droplet	HSLA-75,CS-25	1966	350	196	-	-	-	-	-	-
0496	D-H	CS-60,HSLA-40	1965	1600	859	[141]	[0]	Cloth Belt Filter	CLA,FFSP, FLP,PSP, Reservoir, CT	RTP100	Zero Discharge

TABLE III-2
GENERAL SUMMARY TABLE
VACUUM DEGASSING
PAGE 2

Plant Code	Type of Unit	Type of Steel	Plant Age	Production (Tons/Day) Rated Capacity	Production (Tons/Day) 1976 Production	Flows (Gal/Ton) Applied Flow	Flows (Gal/Ton) Discharge Flow	Treatment Components Process Treatment	Treatment Components Central Treatment	Operating Mode	Discharge Mode
*0576	-	Other-89,HSLA-6 CS-4.4,SS-0.6	1960	260	214	-	-	-	-	-	-
0576A	Stream Droplet	Other-51,AT-10, ES-10,CS-8,SS-1	1959	450	221	475	475	None	None	OT	Direct
0584F	-	CS-100	1968	6554	4160	[240]	[4.4]	CT	-	RUP98.2 BD1.8	-
0684E[1] (No.3 Shop)	Ladle Degassing	SS-90, Other-10	1962	979	120	490	9.8	CT,FLL, FLO1,FLP, CL	-	RTP98 BD2	Direct
0684E (No.4 Shop)	Ladle Degassing	Other-93.8, CS-6.2	1968	2640	637	[3064]	[11.5]	CT,FLL, FLO1,FLP, CL	None	RTP99.6 BD0.4	Direct
*0684H	-	LA-85,CS-15	1965	1200	456	-	-	-	-	-	-
*0684U	-	HSLA-92,CS-8	1958	360	310	-	-	-	-	-	-
*0696A	-	CS-76,Other-24	1976	800	43	-	-	-	-	-	-
*0724A	-	AS-100	-	-	340	-	-	-	-	-	-
*0776E	-	HSLA-100	1958	150	64	-	-	-	-	-	-
*0796A[4] (2 units)	Stream Droplet	HSLA-95.5,CS-4.5 SS-0.05	1964	2496[3]	2208[3]	-	-	-	-	-	-
*0796C	-	HSLA-85,AT-15	1957	90	17	-	-	-	-	-	-
*0796C	-	HSLA-90,AT-10	1965	30	22	-	-	-	-	-	-
*0804A	-	HSLA-93,CS-5, SS-2	1958	150	50	178	178	-	-	OT	Direct
0804B	Stream Droplet	HSLA-60,CS-40	1972	210	138	1071	33	None	SL,SS	RTP97 BD3	Direct
*0840B	-	Other-90,HSLA-10	1970	**	**	-	-	-	-	-	-
0856F[4] (2 units)	D-H	CS-100	1972	1600	535	262	262	PSP	None	OT	Direct

TABLE III-2
GENERAL SUMMARY TABLE
VACUUM DEGASSING
PAGE 3

Plant Code	Type of Unit	Type of Steel	Plant Age	Production (Tons/Day) Rated Capacity	Production (Tons/Day) 1976 Production	Flows (Gal/Ton) Applied Flow	Flows (Gal/Ton) Discharge Flow	Treatment Components Process Treatment	Treatment Components Central Treatment	Operating Mode	Discharge Mode
*0856H	-	HSLA-50,AT-30 CS-20	1964	960	300	-	-	-	-	-	-
*0856R	Ladle Degassing	-	1956	340	208	[436]	[436]	-	-	OT	Direct
0868B	-	CS-78.5, HSLA-21.5	1971	1560	1274	[195]	[2.3]	None	PSP,CT, Filters	RTP98.8 BD1.2	Direct
0896	-	HSLA-90,CS-5 AT-5	1968	-	35	-	-	-	-	-	-
*0946A	-	AT-95,CS-5	1967	3480	90	-	-	-	-	-	-

KEY TO SYMBOLS

- : Inadequate company response.
* : No air or water pollution control equipment.
** : Confidential information.
[ ] : Data listed in brackets was obtained via the responses to the D-DCP questionnaire or during sampling visits.

NOTE: All data was derived from the DCP questionnaire responses with the exception of bracketed data.

KEY TO ABBREVIATIONS

Type of Unit:

R-H: Ruhrstahl-Heraeus
D-H: Dortmund-Horder

Type of Steel:

AS : Alloy Steel
AT : Alloy Tool
CS : Carbon Steel
ES : Electrical Steel
HSLA: High Strength Low Alloy
LA : Low Alloy
SS : Stainless Steel

TABLE III-2
GENERAL SUMMARY TABLE
VACUUM DEGASSING
PAGE 4

Treatment Components and Operating Mode:

For a description of the treatment components and operating modes, see Table VII-1.

Discharge Mode:

Direct : Discharged from the process to a receiving stream.
Indirect : Reused in some other process, then eventually discharged to a receiving stream.
POTW : Discharged from the process to a publicly owned treatment works.
Zero Discharge: No direct or indirect discharge to a receiving stream or a publicly owned treatment works. Process waters are completely recycled.

Footnotes:

(1) Plantis no longer in operation.
(2) Tonnage figures are estimates since the DCP provided only total tonnages for both degassers.
(3) Combined tonnage for the two degassers.
(4) Two identical degassing units. The data presented on this table is the same for both degassers.

TABLE III-3

VACUUM DEGASSING - DATA BASE

	No. of Plants	% of Total No. of Plants	Daily Capacity of Plants (tons)	% of Total Daily Capacity
Plants Sampled for Original Study	4	11.4	8874	20.9
Plants Sampled for Toxic Pollutant Survey	3 incl. 1 above	8.6 incl. 2.9 above	9354 incl. 6554 above	22.0 incl. 15.4 above
Total Plants Sampled	6	17.1	11,674	27.5
Plants Solicited via D-DCP	6 incl. 3 above	17.1 incl. 8.6 above	14,197 incl. 8,574 above	33.4 incl. 20.2 above
Plants Sampled and/or Solicited via D-DCP	9	25.7	17,297	40.7
Plants Responding to DCP	35(1)	100	42,462	100

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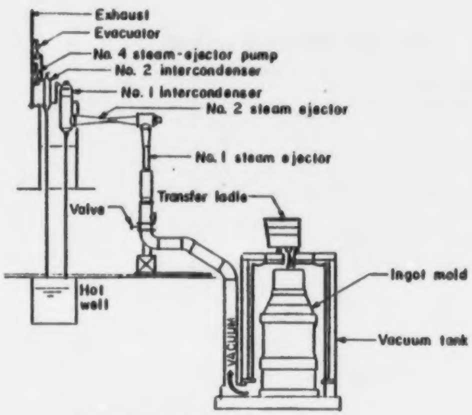
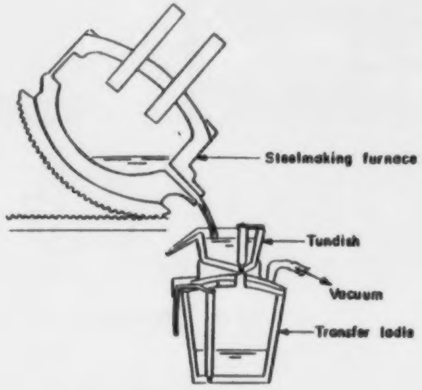
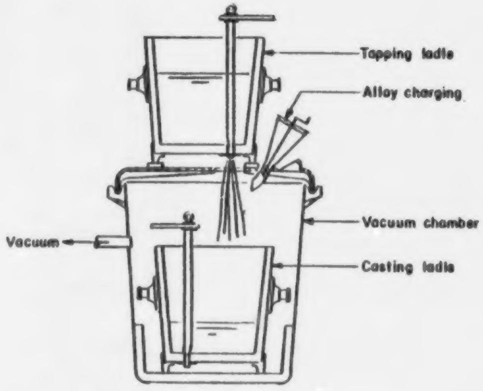
(1) Thirty-four plants are currently in operation. Subcategory costs presented in this report are based upon thirty-four plants.


Exhaust
Evacuator
No. 4 steam-ejector pump
No. 2 intercondenser
No. 1 intercondenser
No. 2 steam ejector
No. 1 steam ejector
Transfer ladle
Valve
Hot well
Ingot mold
VACUUM
Vacuum tank

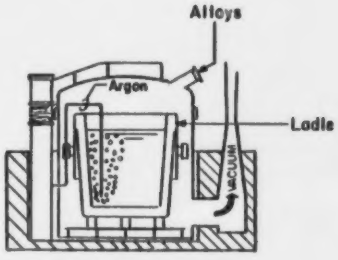
VACUUM INGOT DEGASSING


Steelmaking furnace
Tundish
Vacuum
Transfer ladle

VACUUM TAP DEGASSING


Tapping ladle
Alloy charging
Vacuum
Vacuum chamber
Casting ladle

VACUUM-STREAM-DEGASSING


Alloys
Argon
Ladle
VACUUM

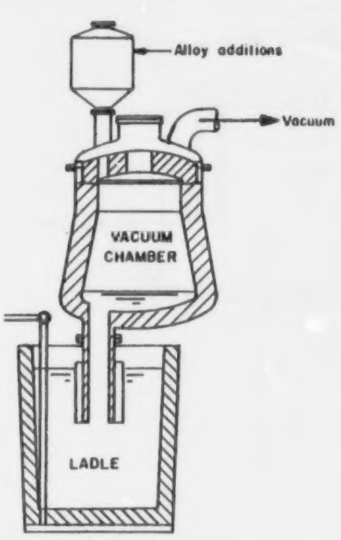
VACUUM FLUSH DEGASSING

ENVIRONMENTAL PROTECTION AGENCY

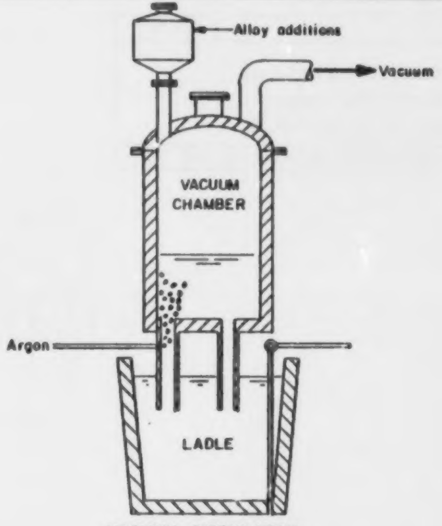
STEEL INDUSTRY STUDY
VACUUM DEGASSING
PROCESS FLOW DIAGRAMS

Dwn. 9/7/79

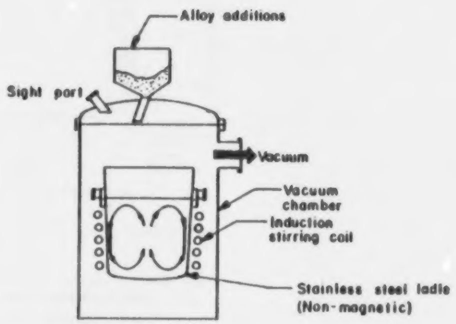
FIGURE III-1


Alloy additions
Vacuum
VACUUM CHAMBER
LADLE

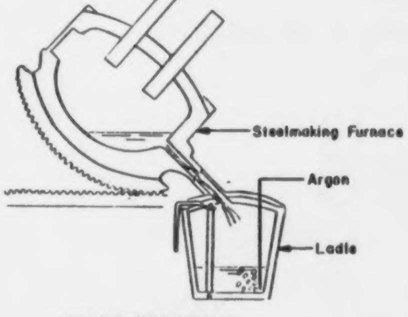
VACUUM LIFTER DEGASSING


Alloy additions
Vacuum
VACUUM CHAMBER
Argon
LADLE

VACUUM CIRCULATING-FLOW DEGASSING


Alloy additions
Sight port
Vacuum
Vacuum chamber
Induction stirring coil
Stainless steel ladle (Non-magnetic)

VACUUM INDUCTION DEGASSING


Steelmaking Furnace
Argon
Ladle

ARGON DEGASSING
(Without vacuum)

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING
PROCESS FLOW DIAGRAMS

Dwn. 9/8/79

FIGURE III-2

VACUUM DEGASSING SUBCATEGORY

SECTION IV

SUBCATEGORIZATION

Introduction

The Agency considered several factors in evaluating whether vacuum degassing is an appropriate subcategory and whether it should be further subdivided. The factors considered were: manufacturing process and equipment; final product; raw materials; wastewater characteristics; wastewater treatability; size; age; geographic location; and, process water usage. The Agency found that none of these factors have a significant effect upon further subdivision of this subcategory. The following discussion addresses each of these factors.

Factors Considered in Subcategorization

Manufacturing Process and Equipment

The vacuum degassing operation is a unique process used to refine molten steel to meet metallurgical requirements not attainable in the steelmaking process. Its particular process characteristics distinguish it from other steelmaking operations in that it is a intermediate step between the tapping of the molten steels from basic oxygen, open hearth or electric furnaces, and the final casting in ingot molds or continuous casting machines. Even though there are seven different types of vacuum degassing systems, the Agency concluded that further subdivision based on the type of degassing process used was not appropriate as the various methods have similar process characteristics. Wastewaters result only when steam jet ejectors are used to develop a vacuum.

Final Products

The vacuum degassing process produces a steel in molten form ready for casting into steel ingots or into billets and blooms in a casting machine. The quantity and quality of the wastewaters generated is thus unrelated to the size, shape or form of the final product. As a result, the Agency concluded that further subdivision on the basis of final product is not appropriate.

Raw Materials

While raw materials have been a principal factor in defining the cokemaking, ironmaking, and steelmaking industry segments, the basic raw material is the same for vacuum degassers. Many different steel compositions can be produced, but alloying is generally accomplished in the steel ladle after the degassing cycle.

The DCP survey of all vacuum degassing plants indicates that only seven of the thirty-four plants in the United States can be classified as carbon steel producers. For purposes of effluent limitations development, a specialty steel plant is defined as any plant which produces less than 50% of its output as carbon steel, and a carbon steel plant is any plant which produces 50% or more of its output as carbon steel. The Agency's examination of wastewater flows (refer to the Summary Tables in Section III) and the analytical data (Tables VII-2 and VII-3) for carbon and specialty steel plants indicates no significant variations in wastewater generation. Accordingly, the Agency has concluded that raw materials do not significantly affect wastewater quality or quantity and thus further subdivision of the subcategory is not appropriate.

Wastewater Characteristics

All steam ejector vacuum degassing operations are generally similar with the only difference being the size of the vacuum equipment required. Equipment size in turn is dependent upon the size of the vacuum chambers and the time required to deliver the required vacuum. Although vacuum degassing wastewaters are distinguishable from those of other steel industry subcategories, a review of the sampling data indicates no discernible pattern or apparent division among the various vacuum degassing plants. It is important to note that vacuum degassing wastewater pollutants result from the gases and dusts generated in the degassing of molten steel, thus indicating similarities in process wastewater characteristics among the various vacuum degassing processes. Any concentration and pollutant variations were unrelated to the type of degassing method employed or type of steel degassed.

Wastewater Treatability

Since vacuum degassing process wastewaters are basically similar, there are no significant differences in wastewater treatability within this subcategory. Therefore, the Agency concluded that no further subdivision based on wastewater treatability is appropriate.

Size and Age

The Agency considered whether the size and age of vacuum degassing operations are appropriate factors for subcategorization. The Agency analyzed possible correlations relating the effects of age and size upon such elements as wastewater flow, wastewater characteristics, and the ability to retrofit treatment equipment to existing facilities. The Agency found no relationships between size and age.

Also, the analysis failed to reveal any correlation between the size of a degassing operation and process water usage or wastewater characteristics. Figure IV-1 is a plot of plant effluent flow (gallon/ton) versus size (in tons/day) for the vacuum degassing subcategory. Also shown are model size and effluent flow. The size of the degassing plant has no significant effect upon the ability to recycle and subsequently attain a low effluent flow rate. A review of analytical data for the sampled plants (presented in Section VII) also shows no relationship between size and the characteristics of the wastewater generated. Thus, the Agency concludes that further subdivision of the subcategory based upon the size of the degassing plant is not appropriate.

The Agency also examined age as a possible basis for subdivision. The concept of age for a degassing plant has little meaning, as the vacuum degassing process is a relatively new development. According to the DCP response data, the oldest degasser now in operation was installed in 1956 while most were built in the 1960's. Hence, there is not much variation in age among degassing plants. The Agency compared effluent flow and age in a manner similar to that for size. Based upon Figure IV-2 the Agency did not find any relationship between plant age and flow. Thus, the Agency concluded that the age of a plant has no significant effect upon the ability to recycle process wastewaters and, thus, attain a low effluent flow.

Further analysis indicated that the age of a degassing plant does not affect the quality or quantity of wastewaters generated. Among the different vacuum degassing systems, older degassers were found to generate the same kinds and amounts of wastewaters as newer ones. Also, the treatability of these wastewaters is similar in all cases.

The problem of retrofitting pollution control equipment was also addressed as part of the plant age analysis. Two older plants have demonstrated the ability to retrofit equipment as shown in Table IV-1. These examples serve to illustrate that pollution control equipment can be installed on older plants. In addition, the cost of retrofit was analyzed to determine whether older plants required additional capital expenditures for the installation of new pollution control equipment over that which is required for new plants. The D-DCPs solicited specific retrofit cost information, and of the six plants surveyed, only one responded that additional costs were incurred. The exact nature of these costs were not detailed. The great majority of plants surveyed indicated that no retrofit costs were incurred. Hence, the Agency concludes that for the subcategory in general, there is no significant difference in wastewater treatment costs for older and newer plants.

Based upon the preceding discussion, neither the size of a degassing plant nor its age were found to have any significant effect upon the nature or treatment of the process wastewaters. Accordingly, the Agency concluded that further subdivision based upon size and age is not appropriate.

Geographic Location

The location of vacuum degassing facilities has no apparent effect for purposes of subdivision. The Agency analyzed the relationship between plant location and process water use and wastewater characteristics. No discernible pattern was revealed. Although a small amount of water will be consumed as a result of using cooling towers, this impact was determined to be minimal. As a result, water consumption is not a significant factor with respect to subdividing this subcategory. Refer to Section VIII.

Process Water Usage

Process water usage was examined as a possible factor for subdivision. However, based upon technical considerations, no further subdivision is necessary. The data were compiled according to the type of degasser used and the type of steel degassed. Although the data indicate that some minor differences in water usage may exist, the Agency determined that with proper treatment, including recycle, all plants can achieve similar wastewater discharge rates.

TABLE IV-1

EXAMPLES OF PLANTS THAT HAVE DEMONSTRATED THE ABILITY TO RETROFIT POLLUTION CONTROL EQUIPMENT

VACUUM DEGASSING CATEGORY

Plant Code	Plant Age (Year)	Treatment Age (Year)
0088A	1963	1971
0496	1965	1971

TABLE IV-2

GEOGRAPHIC LOCATION OF VACUUM DEGASSING OPERATIONS

State	No. of Plants	% of Total
Pennsylvania	16	45.7
Ohio	5	14.3
Texas	4	11.4
Illinois	3	8.6
California	2	5.7
New York	2	5.7
Kentucky	1	2.9
Rhode Island	1	2.9
West Virginia	1	2.9
	35	100

No. of States = 9

FIGURE IV-1

EFFLUENT FLOW vs PLANT SIZE (PRODUCTION CAPACITY)
VACUUM DEGASSING SUBCATEGORY

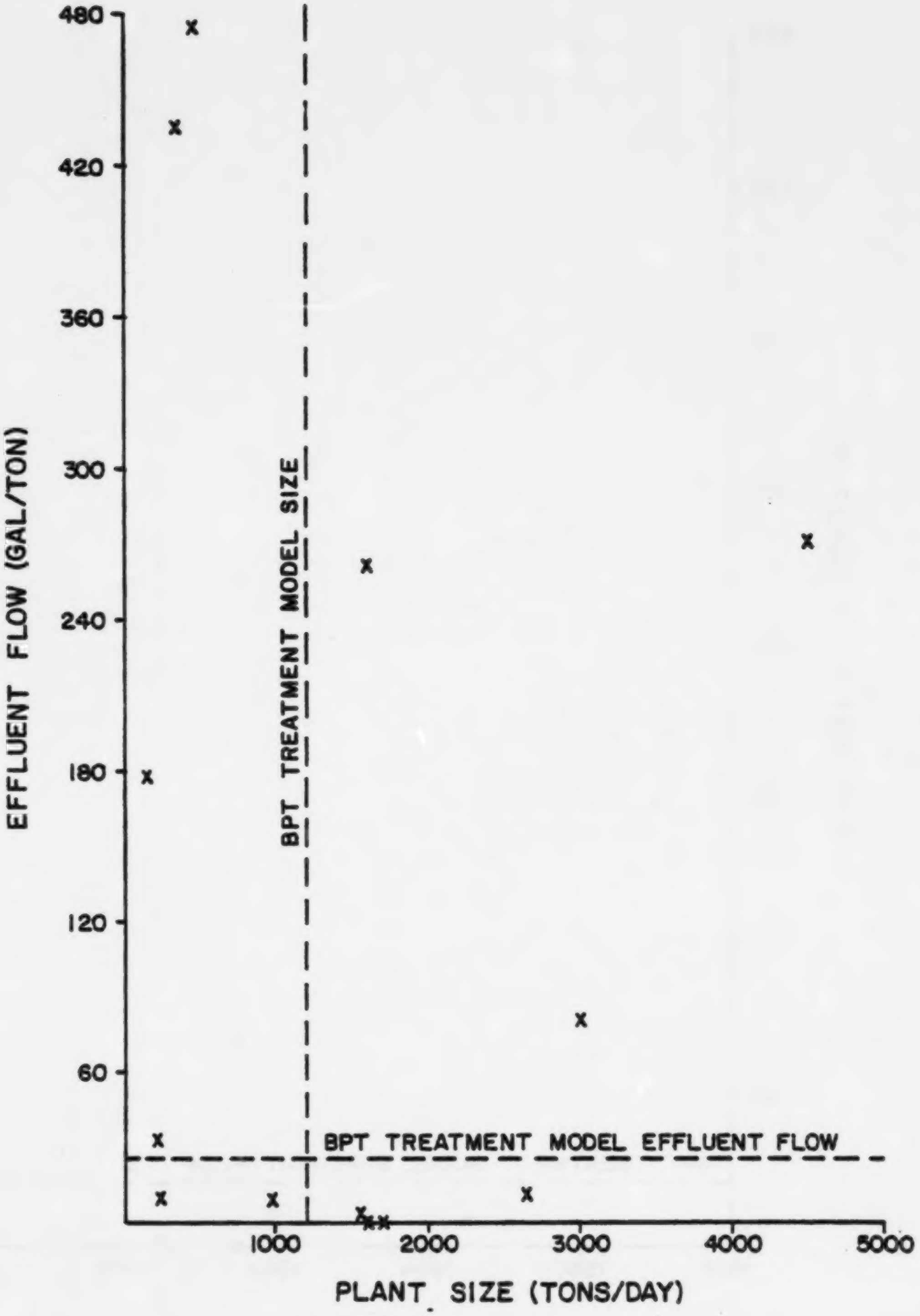
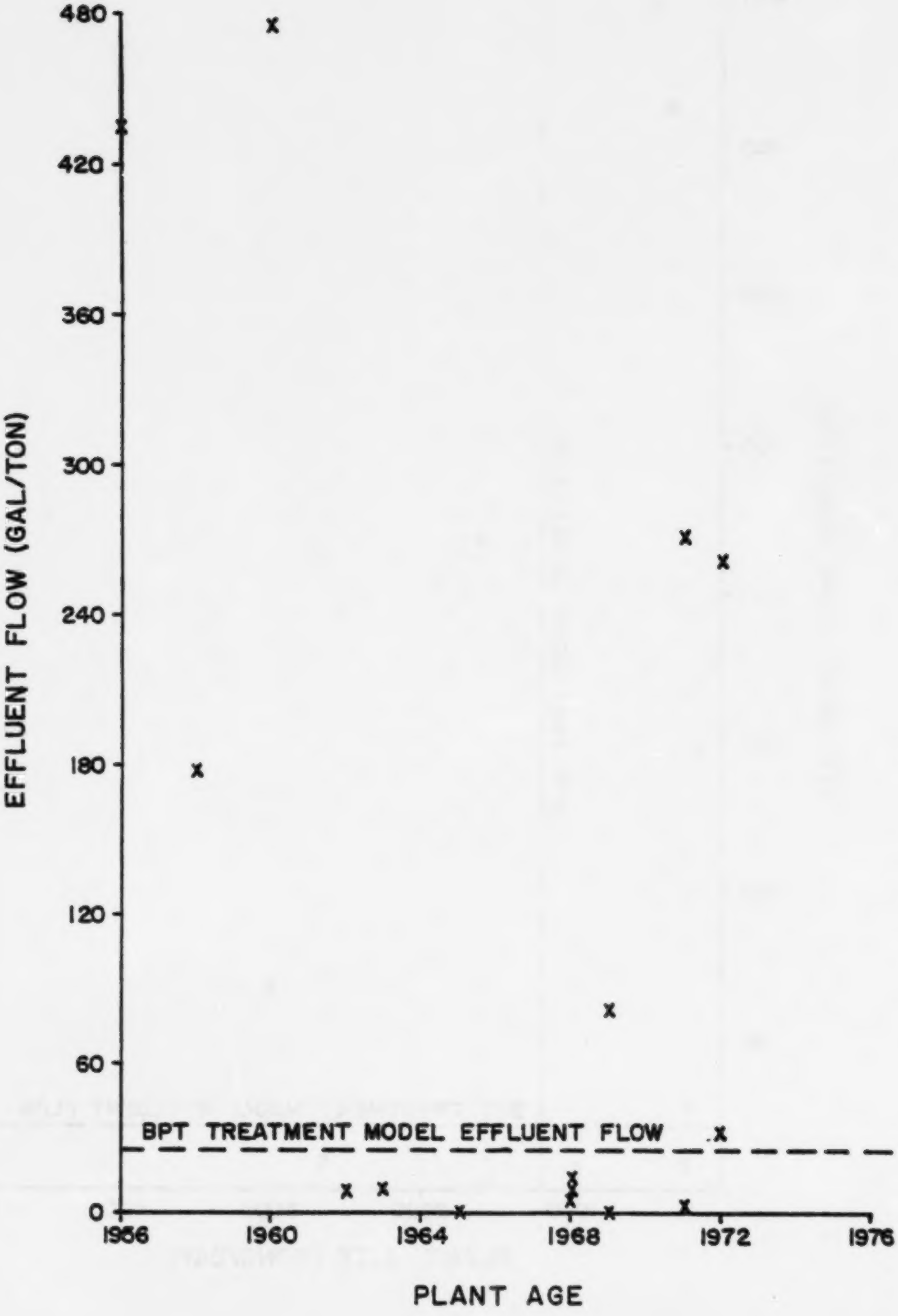


FIGURE IV-2

EFFLUENT FLOW vs PLANT AGE
VACUUM DEGASSING SUBCATEGORY



VACUUM DEGASSING SUBCATEGORY

SECTION V

WATER USE AND WASTE CHARACTERIZATION

Introduction

This section describes the type of wastewaters originating from the process and the wastewater treatment systems presently in use. The description of the water systems is limited to those water systems which come into contact with pollutants generated by the process and excludes the various noncontact cooling water systems. Wastewater characterization is based upon analytical data obtained during field sampling surveys.

Water Use

During the process, vacuum degassing generates fumes and waste gases as a result of the volatilization of impurities in the steel. The hydrogen and nitrogen gases dissolved in the steel are drawn out by the reduced pressures within the vacuum chamber. The oxygen reacts with carbon in the steel and is also drawn out as a gas, again, in response to the reduced pressures of the system. The wastewaters are generated in the vacuum degassing process when steam jet ejector exhaust steam is delivered to condensers where cooling waters condense the steam. The cooling waters, now contaminated with pollutants carried by the system exhaust, are then discharged into a sump (hot well) through a barometric leg (stand-pipe).

Vacuum degassing systems typically contain the following water systems:

1. Barometric condenser cooling waters
2. Flanges, and other miscellaneous equipment noncontact cooling waters.

Only the barometric condenser cooling water system is addressed in this section, as the other water system uses only noncontact cooling waters.

The size of vacuum equipment required for the degassing operation is determined by the vacuum chamber size and the time required to generate the required vacuum. Typical specifications for the vacuum equipment required to degas a 110 ton heat of steel are as follows: (1) degassing time is generally 20 minutes and the time required to pump down to vacuum is 30 seconds to 1 minute; (2) a steam ejector system supplied with two barometric condensers, is rated at 850 lbs/hr of air equivalent at 70°F and a pressure of 4mm Hg; (3) steam is delivered to the system at 120 psig at a rate of 25,400 lbs/hr; (4) thirty four hundred gallons per minute of cooling water, at a maximum temperature of 105°F, is required to condense the steam at the intercondenser; and, (5) the vacuum degasser only operates for a period of approximately 20 minutes per heat cycle.

Degassing is only performed when required by metallurgical specifications. As the steam and water supply only operate during the degassing cycle and the number of heats per day varies, applied and discharge flow rates for the degassing subcategory are based upon gallons per ton per heat. These values were obtained by dividing the total flow during the degassing cycle by the tons of steel degassed.

Cooling towers are required on recycle water systems to reduce the temperature of the water returned for cooling. As noted above, a maximum temperature of 105°F is a typical limit for intercondenser cooling waters.

Table V-1 presents the recycle rates reported in the DCPs, for degassing plants. Most degassing operation wastewater treatment systems have recycle systems which employ cooling towers. A few have large lagoons for cooling, while some use a combination of both lagoons and cooling towers. As noted on this table, industry responses to the DCPs demonstrate very high recycle rates and in several instances, recycle rates of up to 100% are used. With one exception, reported recycle rates equal or exceed 97%, averaging 98.8%.

Waste Characterization

Vacuum degassing process wastewaters contain suspended solids, chromium, copper, lead, nickel, and zinc. The gases emitted from the molten steel come into contact with barometric condenser cooling water during degassing and, as a result, these pollutants are transferred to the water. The removal of the toxic metals from the steel is related to the relative vapor pressures of the various steel bath constituents.

The concentrations presented on Tables V-2 and V-3 provide a measure of the pollutant loads contributed during each pass through the process, thereby, indicating which pollutants are significant with respect to vacuum degassing operations. These concentrations were calculated by subtracting out all "background" pollutant concentrations. The pollutants that are shown (other than the pollutants previously limited) were based on their presence in the raw wastewater at concentrations of 0.010 mg/l or greater.

Table V-2 lists the pickup per pass concentrations of pollutants for plants sampled during the original guidelines survey. As shown in this table, a concentration for Plant E could not be calculated. The make-up water flow to this system was not quantified and thus could not be subtracted to determine pickup per pass concentrations. Table V-3 lists concentrations for all of the plants sampled during the toxic pollutant survey. Concentrations for Plant 065 could not be calculated because of insufficient quality and quantity data for the "background" waters.

The Agency used these pickup per pass concentrations to determine the pollutant loads contributed by the process. However, after reviewing the net and gross concentration values of those pollutants considered for limitation, it was determined that the effect of makeup waters on these streams is insignificant. Accordingly, the Agency has concluded that it is appropriate to propose limitations based upon gross concentration values.

TABLE V-1

RECYCLE RATES
VACUUM DEGASSING SUBCATEGORY

Plant Reference Code	% Recycle
0020B	100
0060	0
0060D	81
0088A	98.6
0248B	100
0496	100
0576A	0
0584F	98
0684E	98
0684E	99.6
0804A	0
0804B	97
0856F	0
0856R	0
0868B	98.8

TABLE V-2

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
VACUUM DEGASSING

Pickup per Pass Concentrations of Pollutants in Raw Wastewaters(1)

Reference Code	0868B	0020B	0856R	
Plant Code	AD	E	G	
Sample Points	(#6-#9)	#16	(#2-#3)	Average
Flow (Gal/Ton)	195	953	436	528
Suspended Solids	34	+	-	17
pH	6.9	+	6.4	6.4 to 6.9
120 Copper	0.65	+	0	0.33
122 Lead	1.2	+	0	0.6
128 Zinc	7.1	+	-	3.6

---

(1) All values are expressed in mg/l unless otherwise noted.

+: Calculation cannot be evaluated.
-: Calculation yielded a negative result.

NOTE: Negative values (-) are counted as zero in calculating averages.

TABLE V-3

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
VACUUM DEGASSING

Pickup per Pass Concentrations of Pollutants in Raw Wastewaters(1)

Reference Code		0496	0584F	0684F	
Plant Code		062	065	068	
Sample Points		(C-B)		(F-E)	Average
Flow (Gal/Ton)		146	234	682	354
	Suspended Solids	13	+	4.5	8.8
	pH (Units)	8.6	+	8.0	8.0-8.6
66	Bis-(2-ethylhexyl) phthalate	-	+	*	*
67	Butyl-benzyl phthalate	0.057	+	0.013	0.035
68	Di-n-butyl phthalate	0.043	+	-	0.022
84	Pyrene	0	+	0.031	0.016
118	Cadmium	0	+	*	*
119	Chromium	0	+	0.019	0.010
120	Copper	0	+	0.010	*
122	Lead	0.35	+	0.21	0.28
124	Nickel	-	+	0	+
126	Silver	-	+	*	*
127	Thallium	0	+	NR	0
128	Zinc	2.0	+	0.23	1.1

---

(1) All values are expressed in mg/l unless otherwise noted.

* : Net concentration is less than 0.010 mg/l.
- : Calculation yielded negative result.
+ : Calculation cannot be evaluated.
0 : Zero value (included in average).
NR: Not reported.

NOTE: Negative values (-) are counted as zero in calculating averages.

VACUUM DEGASSING SUBCATEGORY

SECTION VI

WASTEWATER POLLUTANTS

Introduction

This section discusses the Agency's selection of pollutants considered for limitation, the rationale for selecting these pollutants, and the process sources of these pollutants. The initial step in the selection process involved the development of a list of pollutants which the Agency considered to be representative of the vacuum degassing process based upon data gathered during the original guidelines survey and from the DCP responses. The Agency then supplemented that list based upon analytical data gathered during the toxic pollutant survey. In selecting the pollutants for which limitations are being proposed, the Agency reviewed all analytical data, considered the impact of each pollutant and assessed its ability to serve as an "indicator" for other pollutants found in the wastewaters.

Conventional Pollutants

Suspended solids and pH were limited in the 1974 BPT regulation. The Agency selected suspended solids because of the particulates generated by the process which subsequently contaminate the process wastewaters. These gases subsequently come into contact with intercondenser cooling waters, thus resulting in the transfer of these particulates to the cooling waters. In addition, suspended solids provides an indication of the degree of process wastewater contamination and of the extent of wastewater treatment. Removal of the suspended solids will also result in the removal of certain toxic pollutants (e.g., toxic metals). Thus, the extent of wastewater pollution and the technology required to treat the wastewaters may be ascertained.

Finally, the Agency selected pH, a measure of the acidity or alkalinity of a wastewater, because of the environmentally detrimental effects which can result from extremes in pH. In addition, extremes in pH can cause problems, such as corrosion and scaling, with process and wastewater treatment equipment and facilities. The Agency found the pH of vacuum degassing process wastewaters to be typically in the range of 6.0 to 9.0.

Toxic Pollutants

The Agency also is proposing limitations for toxic pollutants. Initially, the Agency reviewed all pollutants which it believed were in vacuum degassing wastewaters based upon industry responses to the DCPs, analyses performed during the screening phase of the project, and its knowledge of the characteristics of vacuum degassing wastewaters. Table VI-1 presents a list of these pollutants.

After completing the analytical efforts for vacuum degassing operations, the Agency tabulated the data and calculated a net (pickup per pass) concentration value for each pollutant detected in the raw wastewaters at a concentration of 0.010 mg/l or greater. The Agency used net raw concentrations for the reasons noted in Section V. The Agency excluded from further consideration for limitation those pollutants which were not found at an average net raw concentration of 0.010 mg/l or greater. The list of these pollutants, including the conventional pollutants, is presented in Table VI-2.

The toxic metal pollutants are found in the process wastewaters as a result of the removal of these metals from the molten steel during the degassing process. These metals (oxides) are carried away in the off-gases which subsequently mix with the intercondenser cooling waters.

The selected list of pollutants, Table VI-2, does not include any of the toxic organic pollutants although several meet the net raw wastewater concentration considerations noted above. The Agency is not proposing limitations for one class of toxic organic pollutants (phthalates) because it believes that its appearance during the sampling process resulted from sampling and laboratory procedures, not because it is a pollutant whose source is in the vacuum degassing process. The Agency is not proposing limitations for the remaining toxic organic pollutant (pyrene) because treatment for this pollutant, at the levels at which it is found, is generally unfeasible. In addition, the Agency believes that these pollutants do not tend to concentrate in recycle systems. Therefore, the discharge loadings of these pollutants will be reduced proportionately to the degree of recycle. The proposed limitations (refer to Sections IX and X) will incorporate the pollutant load reductions attainable by the use of recycle systems.

Other pollutants (i.e., chloride, sulfate) are present at substantial levels in the process wastewaters, but are not included in the list of selected pollutants since they are generally nontoxic and difficult to remove. Treatment of these pollutants is not commonly practiced in wastewater treatment operations in any industry.

TABLE VI-1

TOXIC POLLUTANTS KNOWN TO BE PRESENT VACUUM DEGASSING OPERATIONS

4. Benzene
6. Carbon Tetrachloride
23. Chloroform
65. Phenol
66. Bis(2-ethylhexyl) phthalate
67. Butyl benzyl phthalate
68. Di-n-butyl phthalate
84. Pyrene
85. Tetrachloroethylene
86. Toluene
114. Antimony
115. Arsenic
118. Cadmium
119. Chromium
120. Copper
122. Lead
124. Nickel
125. Selenium
126. Silver
127. Thallium
128. Zinc

TABLE VI-2

SELECTED POLLUTANTS
VACUUM DEGASSING SUBCATEGORY

Suspended Solids

pH

Chromium

Copper

Lead

Nickel

Zinc

VACUUM DEGASSING SUBCATEGORY

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

Introduction

A review of the control and treatment technologies currently in use or available for use in the vacuum degassing subcategory provided the basis for selecting and developing the BPT, BAT, NSPS, PSNS, and PSES model treatment systems. For this purpose, questionnaire and plant visit data were summarized to identify those treatment components and systems in use. Capabilities, either demonstrated in this or in other operations (refer to Volume I) or based upon engineering considerations, were used in evaluating the various treatment technologies. These considerations were then used to determine which treatment components are most appropriate for the various treatment levels. This section presents a summary of the treatment practices currently in use or available for use in the treatment of vacuum degassing process wastewaters.

This section also presents the raw wastewater and treated effluent analytical data for the plants sampled and the effluent analytical data provided in the D-DCPs. Also included are descriptions of the treatment systems at each sampled plant.

Summary of Treatment Practices Currently Employed

A survey of treatment components used in the vacuum degassing subcategory indicates that all plants, for which DCP responses were provided, include gravity sedimentation (as a primary step in many instances). Most plants also recycle their wastewaters, typically after passing them through a cooling tower, lagoon, or cooling tower and lagoon combination. Most plants also treat the process wastewaters further in central (i.e., multi-waste source or multi-operational waste source) treatment facilities which provide additional treatment using either filters or clarifiers in conjunction with lime or polymer flocculation.

Referring to Table III-2, the Agency has found that the following treatment technologies are in use at most plants for which DCP responses were provided.

A. Scale pit, hot well or similar sedimentation device-

Intended to provide primary sedimentation of the raw process wastewaters.

B. Cooling towers-

Permit the recycle of process wastewaters by reducing the wastewater heat load.

C. Recycle-

Nearly all (>98%) of the cooling tower effluent is returned to the process.

The Agency has included the above components in the BPT model treatment system based upon their widespread use in the treatment of vacuum degassing process wastewaters.

Control and Treatment
Technologies for BAT, NSPS, PSES, and PSNS

Because of the presence of toxic inorganic pollutants in vacuum degassing wastewaters, the Agency considered advanced treatment systems to serve as model technologies for BAT, NSPS, PSES, and PSNS. A brief discussion of each of the technologies considered by the Agency is presented below.

Filtration technology is a common and effective means of removing suspended solids, and those pollutants (particularly the toxic metals) entrained in these solids, from process wastewaters. Twenty-five percent of the vacuum degassing plants for which treatment system data were provided, use filters in the treatment of process wastewaters. Generally, the filter bed is comprised of one or more filter media (such as sand, anthracite, garnet) although a variety of filtration systems are available (flat bed, deep bed, cloth belt, pressure, or gravity). Filtration is incorporated as a treatment technology for vacuum degassing operations primarily to reduce the discharge of toxic metals.

Systems using a sulfide compound addition to the wastewater stream have been shown to be capable of reducing effluent dissolved metals concentrations below the levels achieved in lime precipitation reactions. Some of the toxic metals which can effectively be precipitated with sulfide are zinc, copper, nickel, lead, and silver. The increased removal efficiencies are attributable to the comparative solubilities of metal sulfides and metal hydroxides. In general, the metal sulfides are less soluble than the respective metal hydroxides. However, it is important to note that an excess of sulfide in a treated effluent can result in objectionable odor problems. A decrease in wastewater pH will aggravate this problem, and if wastewater treatement pH control problems result in even a slightly acidic pH, operating personnel can be adversely affected. One method of controlling the presence of excess sulfide in the treated effluent involves the feeding of an iron sulfide slurry. Ferrous sulfide will not readily dissociate in the waste stream, with the result that the free sulfide level is kept well below objectionable limits. However, the affinities of the other metals in the waste stream for sulfide are greater than that of iron. Hence, the other metal sulfide precipitates are formed preferentially to iron sulfide. Once the sulfide requirements of the other metal precipitates are satisfied, the remaining sulfide remains as a ferrous precipitate and the excess iron from the sulfide is precipitated as a hydroxide. By using filtration following sulfide addition, insurance can be provided that the treatment system achieves the optimum reductions in toxic metal pollutants.

The Agency considered vapor compression distillation as a possible means of attaining zero discharge of wastewaters in the vacuum degassing subcategory. The resulting slurry would be dried by various means, while the distillate quality effluent would be recycled to the process. However, the Agency rejected using this technology as a model treatment system since this technology would consume from 50 to over 100 times more energy than the other BAT alternatives considered.

Summary of Analytical Data

Raw wastewater and effluent analytical data for the vacuum degassing operations visited during the original and toxic pollutant surveys are presented in Tables VII-2 and VII-3. Plant AC, which was sampled during the original survey, was resampled as Plant 065 during the toxic pollutant survey. Table VII-1 provides a legend for the various control and treatment technology abbreviations used in the above tables and in other tables throughout this report.

The concentrations presented in the above tables represent, except where footnoted, averages of measured values. In some cases, these data represent the values of central treatment systems. The effluent waste loads (lb/1000 lb) for central treatment systems represent apportioned loads. In these central treatment systems, the percentage contribution of an individual operation to the total treatment system influent load was determined and subsequently applied to the total effluent load. By using this procedure, the Agency assessed the effects of treatment on the waste loads of an individual process which discharges to a central treatment facility.

As a supplement to the sampled plant analytical data, effluent data from plant D-DCP responses are presented in Table VII- 4. Table VII-5 summarizes the typical vacuum degassing process wastewater characteristics determined from the sampled plant analytical data.

Plant Visits

Treatment facilities for the visited plants are described below. Reference is made to the respective treatment flow schematics which are presented at the end of this section.

Plant AD (Figure VII-1)

The vacuum degasser at this plant uses a combined treatment system in conjunction with a continuous caster. The treatment system consists of a scale pit, high flow pressure filters, a cooling tower, and a recycle system. The blowdown from this system is less than 1%.

Plant 062 (Figure VII-2)

This plant uses a combined treatment system for its vacuum degasser and continuous caster wastewaters. Vacuum degasser wastewaters are discharged to a hot well from which a sidestream is treated through a cloth belt filter. The filter effluent and the remaining degasser wastewaters are then discharged to a main hot well. From the hot well, the combined degasser and caster wastewaters are treated through a scale pit, sand filters and cooling tower. A recycle is taken from the cooling tower back to the degasser. This system reports an overall zero discharge. All of its wastewaters are recirculated through a twenty million gallon reservoir.

Plant 065 (Figure VII-3)

Vacuum degasser wastewaters are discharged to a hot well and recirculated through a cooling tower back to the process.

Plant E (Figure VII-4)

The treatment system for this plant is identical to the system for Plant 065. Degasser wastewaters are completely recirculated from a hot well, through a cooling tower, and back to the process.

Plant G (Figure VII-5)

Degasser wastewaters empty into a hot well and are then discharged to a receiving stream. This system operates on a once-through basis.

Plant 068 (Figure VII-6)

Vacuum degasser wastewaters discharge to a hot well and are then treated in a central treatment facility. Central treatment includes deep bed filters and clarifiers. A recycle is taken from the central treatment facility to vacuum degassing and other plant operations.

TABLE VII-1

OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS

Symbols

A. **Operating Modes**

1. OT — Once-Through

2. Rt,s,n — Recycle, where t = type waste
s = stream recycled
n = % recycled

t: U = Untreated
T = Treated

	s	n
P	Process Wastewater	% of raw waste flow
F	Flume Only	% of raw waste flow
S	Flume and Sprays	% of raw waste flow
FC	Final Cooler	% of FC flow
BC	Barometric Cond.	% of BC flow
VS	Abs. Vent Scrub.	% of VS flow
FH	Fume Hood Scrub.	% of FH flow

3. REt,n — Reuse, where t = type
n = % of raw waste flow

t: U = before treatment
T = after treatment

4. BDn — Blowdown, where n = discharge as % of raw waste flow

B. **Control Technology**

10. DI — Deionization

11. SR — Spray/Fog Rinse

12. CC — Countercurrent Rinse

13. DR — Drag-out Recovery

C. **Disposal Methods**

20. H — Haul Off-Site

21. DW — Deep Well Injection

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 2

C. Disposal Methods (cont.)

22.	Qt,d	Coke Quenching, where t = type d = discharge as % of makeup t: DW = Dirty Water CW = Clean Water
23.	EME	Evaporation, Multiple Effect
24.	ES	Evaporation on Slag
25.	EVC	Evaporation, Vapor Compression Distillation

D. Treatment Technology

30.	SC	Segregated Collection
31.	E	Equalization/Blending
32.	Scr	Screening
33.	OB	Oil Collecting Baffle
34.	SS	Surface Skimming (oil, etc.)
35.	PSP	Primary Scale Pit
36.	SSP	Secondary Scale Pit
37.	EB	Emulsion Breaking
38.	A	Acidification
39.	AO	Air Oxidation
40.	GF	Gas Flotation
41.	M	Mixing
42.	Nt	Neutralization, where t = type t: L = Lime C = Caustic A = Acid W = Wastes O = Other, footnote

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 3

D. Treatment Technology (cont.)

43.	FLt	Flocculation, where t = type t: L = Lime A = Alum P = Polymer M = Magnetic O = Other, footnote
44.	CY	Cyclone/Centrifuge/Classifier
44a.	DT	Drag Tank
45.	CL	Clarifier
46.	T	Thickener
47.	TP	Tube/Plate Settler
48.	SLn	Settling Lagoon, where n = days of retention time
49.	BL	Bottom Liner
50.	VF	Vacuum Filtration (of e.g., CL, T, or TP underflows)
51.	Ft,m,h	Filtration, where t = type m = media h = head

t	m	h
D = Deep Bed	S = Sand	G = Gravity
F = Flat Bed	O = Other, footnote	P = Pressure

52.	CLt	Chlorination, where t = type t: A = Alkaline B = Breakpoint
53.	CO	Chemical Oxidation (other than CLA or CLB)

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT
TECHNOLOGIES AND DISPOSAL METHODS
PAGE 4

D. Treatment Technology (cont.)

54.	BOt	Biological Oxidation, where t = type t: An = Activated Sludge n = No. of Stages T = Trickling Filter B = Biodisc O = Other, footnote
55.	CR	Chemical Reduction (e.g., chromium)
56.	DP	Dephenolizer
57.	ASt	Ammonia Stripping, where t = type t: F = Free L = Lime C = Caustic
58.	APt	Ammonia Product, where t = type t: S = Sulfate N = Nitric Acid A = Anhydrous P = Phosphate H = Hydroxide O = Other, footnote
59.	DSt	Desulfurization, where t = type t: Q = Qualifying N = Nonqualifying
60.	CT	Cooling Tower
61.	AR	Acid Regeneration
62.	AU	Acid Recovery and Reuse
63.	ACt	Activated Carbon, where t = type t: P = Powdered G = Granular
64.	IX	Ion Exchange
65.	RO	Reverse Osmosis
66.	D	Distillation

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT
TECHNOLOGIES AND DISPOSAL METHODS
PAGE 5

D. Treatment Technology (cont.)

67.	AA1	Activated Alumina
68.	OZ	Ozonation
69.	UV	Ultraviolet Radiation
70.	CNTt,n	Central Treatment, where t = type n = process flow as % of total flow t: 1 = Same Subcats. 2 = Similar Subcats. 3 = Synergistic Subcats. 4 = Cooling Water 5 = Incompatible Subcats.
71.	On	Other, where n = Footnote number
72.	SB	Settling Basin
73.	AE	Aeration
74.	PS	Precipitation with Sulfide

TABLE VII-2

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
VACUUM DEGASSING

Raw Wastewaters

Reference Code	0868B		0020B		0856R			
Plant Code	AD		E		G			
Sampling Point(s)	#6		#16		#2			
Flow, (Gal/Ton)	195		953		436		Average 528	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	56	0.046	206	0.82	14	0.0026	92	0.29
pH (Units)	6.9		6.5		6.4		6.4-6.9	
119 Chromium	NA	NA	0.01	Neg.	0.01	Neg.	0.01	Neg.
120 Copper	0.9	0.00074	0.08	0.00032	0.01	Neg.	0.33	0.00036
122 Lead	1.5	0.0012	0.03	0.00012	0.03	Neg.	0.52	0.00046
124 Nickel	NA	NA	0.45	0.0018	0.01	Neg.	0.23	0.00091
128 Zinc	8.7	0.0071	0.37	0.0015	0.01	Neg.	3.0	0.0029

Treated Effluent

Reference Code	0868B		0020B		0856R	
Plant Code	AD		E		G	
Sampling Point(s)	#9		#16		#2	
Flow (Gal/Ton)	2.3		0		436	
C&TT	PSP,FD(UNK)P,RTP98.8		CT,RUP100		OT	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	22	0.00021	206	0	14	0.0026
pH (Units)	6.8		6.5		6.4	
119 Chromium	NA	NA	0.01	0	0.01	Neg.
120 Copper	0.25	Neg.	0.08	0	0.01	Neg.
122 Lead	0.32	Neg.	0.03	0	0.03	Neg.
124 Nickel	1.6	Neg.	0.45	0	0.01	Neg.
128 Zinc	NA	NA	0.37	0	0.01	Neg.

NA : Not analyzed.
Neg.: Value for lbs/1000 lbs is less than 0.0001.

NOTE: For the definition of C&TT codes, see Table VII-1.

TABLE VII-3

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
VACUUM DEGASSING

Raw Wastewaters

Reference Code	0496		0584F		0684H					
Plant Code	062		065		068				Overall Average(1)	
Sampling Point(s)	C		H		F		Average			
Flow, (Gal/Ton)	146		234		682		354		441	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	30	0.018	29	0.029	12	0.034	24	0.027	58	0.16
pH (Units)	7.8-9.1		4.5-5.7		8.0-8.2		4.5-9.1		4.5-9.1	
119 Chromium	0.033	Neg.	3.0	0.029	0.025	Neg.	1.0	0.0097	0.51	0.0049
120 Copper	0.133	Neg.	0.443	0.00044	0.020	Neg.	0.20	0.00019	0.27	0.00028
122 Lead	0.47	0.00029	3.2	0.0031	0.24	0.00069	1.30	0.0014	0.91	0.00093
124 Nickel	0.023	Neg.	0.5	0.00049	*	*	0.26	0.00025	0.24	0.00058
128 Zinc	2.5	0.0015	24	0.024	0.26	0.00074	8.9	0.0087	6.0	0.0058

Treated Effluent

Reference Code	0496		0584F		0684H	
Plant Code	062		065		068	
Sampling Point(s)	E		H		F	
Flow, (Gal/Ton)	0		0		682	
C&TT	PSP CT,FDS(UNK),RET100		CT,RUP100		CT	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	16	(2)	29	0	12	0.034
pH (Units)	7.6-8.1		4.5-5.7		8.0-8.2	
119 Chromium	0.026	(2)	3.0	0	0.025	Neg.
120 Copper	0.207	(2)	0.443	0	0.020	Neg.
122 Lead	0.060	(2)	3.2	0	0.24	0.00069
124 Nickel	<0.010	(2)	0.5	0	*	*
128 Zinc	0.333	(2)	24	0	0.26	0.00074

---

(1) Average of all values on Tables VII-2 and VII-3.
(2) No wastewaters are discharged to a receiving stream for all plant wastewaters are combined and recycled.

Neg.: Value for lbs/1000 lbs is less than 0.0001.

NOTE: For the definition of C&TT codes, see Table VII-1.

TABLE VII-4

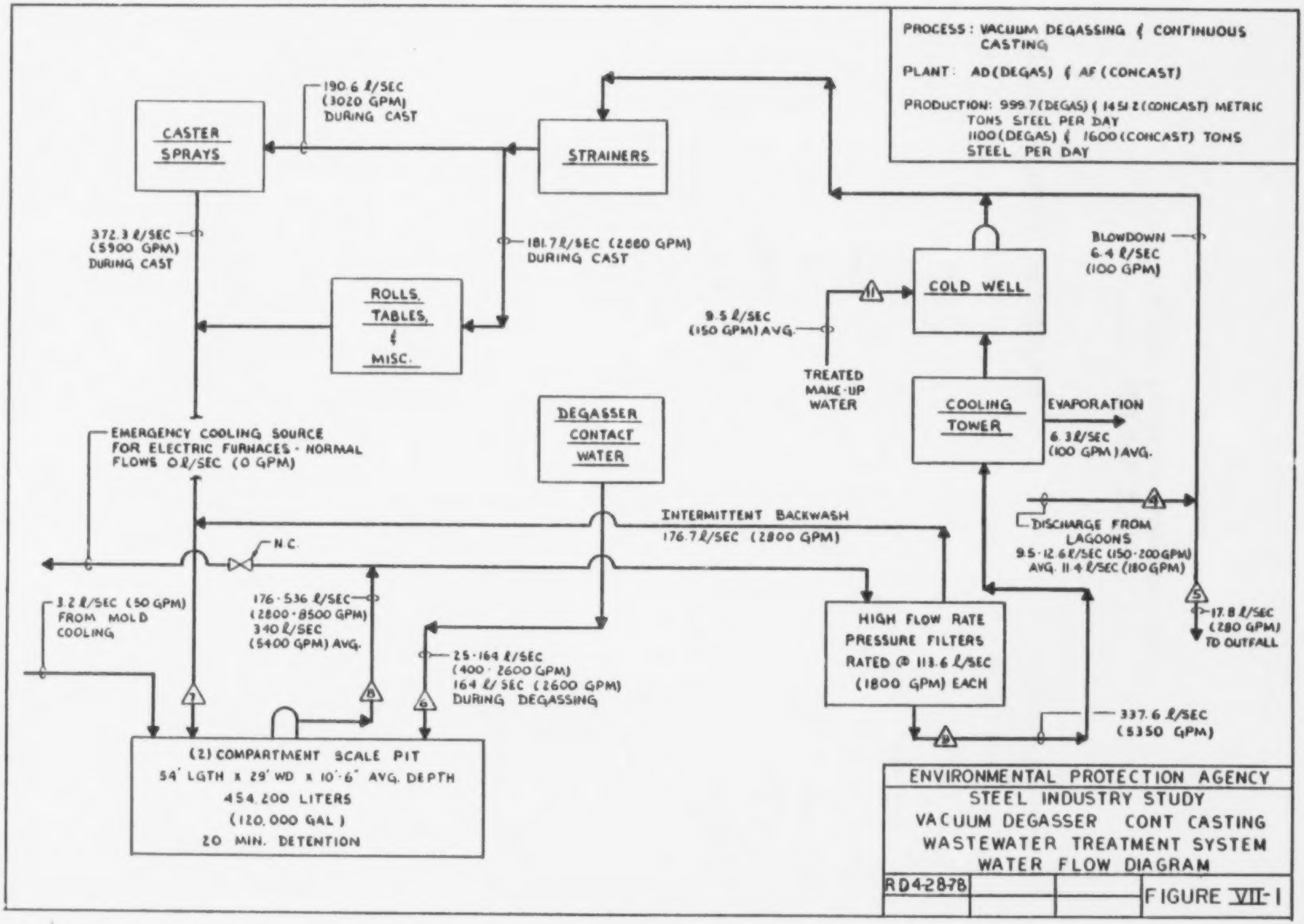
ANALYSIS OF D-DCP DATA
VACUUM DEGASSING

Parameter	Plant 0584F				Plant 0684E			
	No. of Analyses	Avg.	Max.	Std. Dev.	No. of Analyses	Avg.	Max.	Std. Dev.
Suspended Solids (mg/l)	3	29	44	13	11	45	96	22.4
pH (Units)	3	4.9	5.7	-	11	8.4	8.5	-
122 Lead (mg/l)	3	2.8	3.7	0.5	3	0.653	0.400	0.234
128 Zinc (mg/l)	3	24	28	5	3	1.39	1.84	0.51

TABLE VII-5

RAW WASTEWATER CHARACTERIZATION
VACUUM DEGASSING

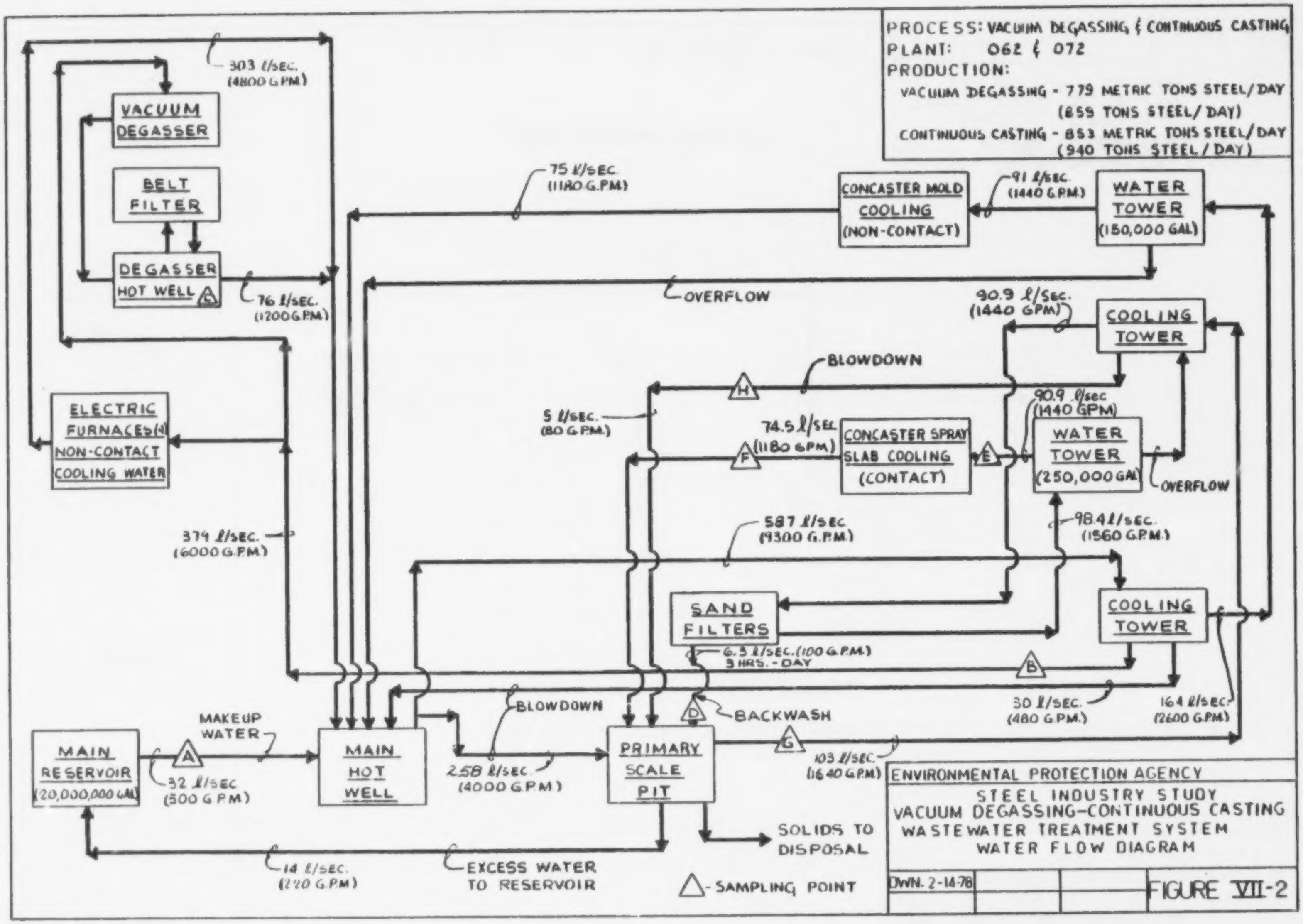
Pollutant Parameters		Raw Waste Concentration (mg/l)
	Suspended Solids	80
	pH (Units)	6-9
119	Chromium	1.0
120	Copper	0.20
122	Lead	5.0
124	Nickel	0.030
128	Zinc	5.0



PROCESS: VACUUM DEGASSING & CONTINUOUS CASTING
PLANT: AD (DEGAS) & AF (CONCAST)
PRODUCTION: 999.7 (DEGAS) & 1451.2 (CONCAST) METRIC TONS STEEL PER DAY
1100 (DEGAS) & 1600 (CONCAST) TONS STEEL PER DAY
CASTER SPRAYS
STRAINERS
190.6 ℓ/SEC (3020 GPM) DURING CAST
372.3 ℓ/SEC (5900 GPM) DURING CAST
181.7 ℓ/SEC (2880 GPM) DURING CAST
ROLLS, TABLES, & MISC.
BLOWDOWN 6.4 ℓ/SEC (100 GPM)
COLD WELL
9.5 ℓ/SEC (150 GPM) AVG.
11
TREATED MAKE-UP WATER
COOLING TOWER
EVAPORATION
6.3 ℓ/SEC (100 GPM) AVG.
DEGASSER CONTACT WATER
EMERGENCY COOLING SOURCE FOR ELECTRIC FURNACES - NORMAL FLOWS 0 ℓ/SEC (0 GPM)
INTERMITTENT BACKWASH
176.7 ℓ/SEC (2800 GPM)
N.C.
4
DISCHARGE FROM LAGOONS
9.5-12.6 ℓ/SEC (150-200 GPM)
AVG. 11.4 ℓ/SEC (180 GPM)
5
17.8 ℓ/SEC (280 GPM) TO OUTFALL
3.2 ℓ/SEC (50 GPM) FROM MOLD COOLING
176-536 ℓ/SEC (2800-8500 GPM)
340 ℓ/SEC (5400 GPM) AVG.
25-164 ℓ/SEC (400-2600 GPM)
164 ℓ/SEC (2600 GPM) DURING DEGASSING
HIGH FLOW RATE PRESSURE FILTERS RATED @ 113.6 ℓ/SEC (1800 GPM) EACH
7
8
6
9
337.6 ℓ/SEC (5350 GPM)
(2) COMPARTMENT SCALE PIT
54' LGTH x 29' WD x 10'-6" AVG. DEPTH
454,200 LITERS
(120,000 GAL)
20 MIN. DETENTION
RD42878

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
VACUUM DEGASSER CONT CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-1

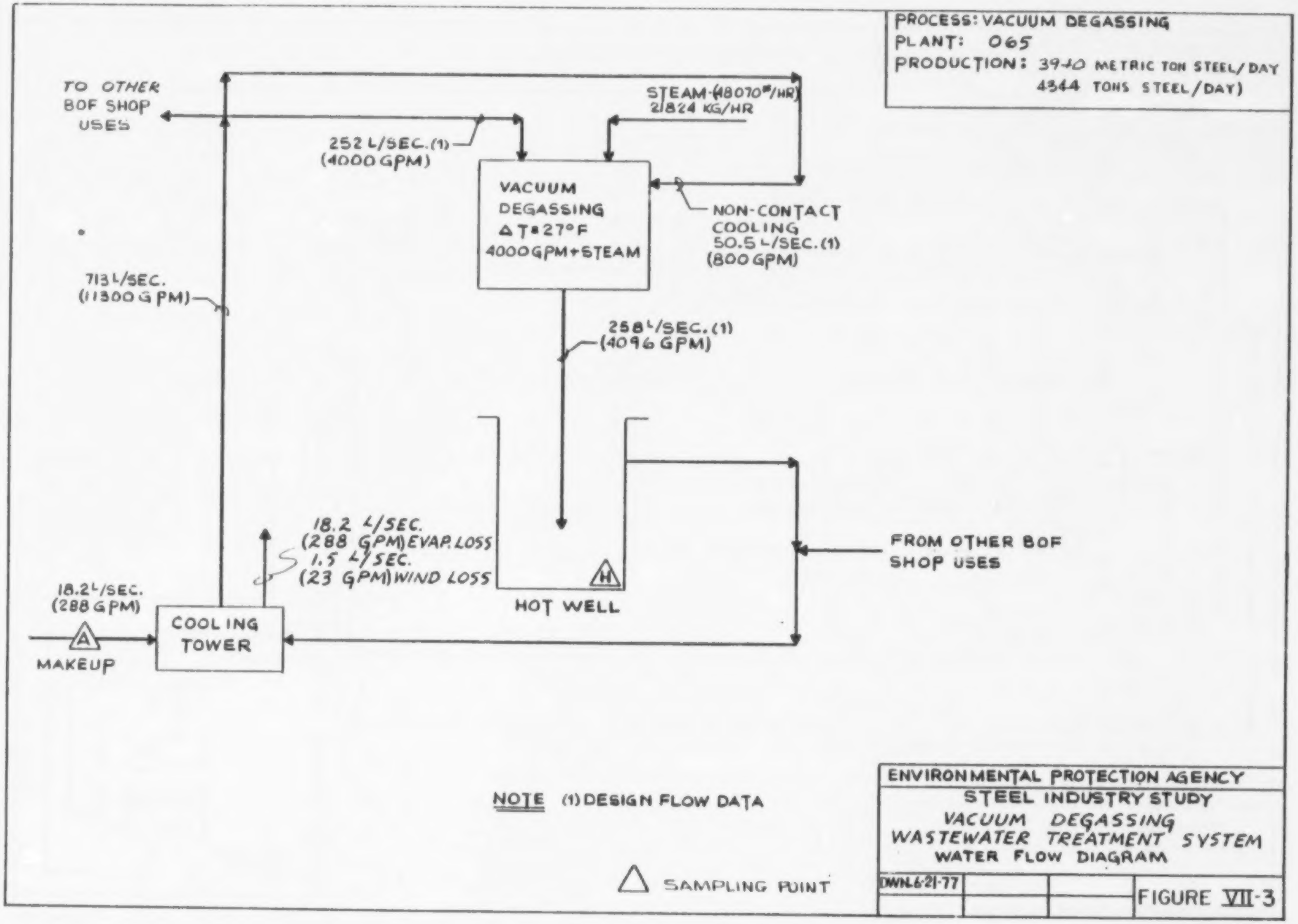

303 l/sec. (4800 G.P.M)
VACUUM DEGASSER
BELT FILTER
DEGASSER HOT WELL
C
76 l/sec. (1200 G.P.M)
75 l/sec. (1180 G.P.M)
CONCASTER MOLD COOLING (NON-CONTACT)
91 l/sec. (1440 G.P.M)
WATER TOWER (150,000 GAL)
OVERFLOW
90.9 l/sec. (1440 GPM)
COOLING TOWER
BLOWDOWN
H
ELECTRIC FURNACES(4) NON-CONTACT COOLING WATER
5 l/sec. (80 G.P.M.)
74.5 l/sec (1180 GPM)
F
CONCASTER SPRAY SLAB COOLING (CONTACT)
E
90.9 l/sec (1440 GPM)
WATER TOWER (250,000 GAL)
OVERFLOW
379 l/sec. (6000 G.P.M.)
587 l/sec. (9300 G.P.M.)
98.4 l/sec. (1560 G.P.M.)
SAND FILTERS
COOLING TOWER
6.3 l/sec. (100 G.P.M.) 3 HRS. - DAY
B
30 l/sec. (480 G.P.M.)
164 l/sec. (2600 G.P.M.)
BLOWDOWN
D
BACKWASH
MAKEUP WATER
MAIN RESERVOIR (20,000,000 GAL)
A
32 l/sec (500 G.P.M)
MAIN HOT WELL
2.58 l/sec. (4000 G.P.M)
PRIMARY SCALE PIT
G
103 l/sec. (1640 G.P.M)
SOLIDS TO DISPOSAL
14 l/sec. (220 G.P.M)
EXCESS WATER TO RESERVOIR
△ - SAMPLING POINT

PROCESS: VACUUM DEGASSING & CONTINUOUS CASTING
PLANT: 062 & 072
PRODUCTION:
VACUUM DEGASSING - 779 METRIC TONS STEEL/DAY
(859 TONS STEEL/DAY)
CONTINUOUS CASTING - 853 METRIC TONS STEEL/DAY
(940 TONS STEEL/DAY)

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
VACUUM DEGASSING-CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

DWN. 2-14-78

FIGURE VII-2


PROCESS: VACUUM DEGASSING
PLANT: 065
PRODUCTION: 3940 METRIC TON STEEL/DAY
4344 TONS STEEL/DAY)
TO OTHER BOF SHOP USES
STEAM-(48070#/HR)
21824 KG/HR
252 L/SEC.(1)
(4000 GPM)
VACUUM DEGASSING
ΔT=27°F
4000GPM+STEAM
NON-CONTACT COOLING
50.5 L/SEC.(1)
(800 GPM)
713 L/SEC.
(11300 GPM)
258 L/SEC.(1)
(4096 GPM)
18.2 L/SEC.
(288 GPM) EVAP. LOSS
1.5 L/SEC.
(23 GPM) WIND LOSS
18.2 L/SEC.
(288 GPM)
A
MAKEUP
COOLING TOWER
H
HOT WELL
FROM OTHER BOF SHOP USES
NOTE (1) DESIGN FLOW DATA
△ SAMPLING POINT
DWN. 6-21-77

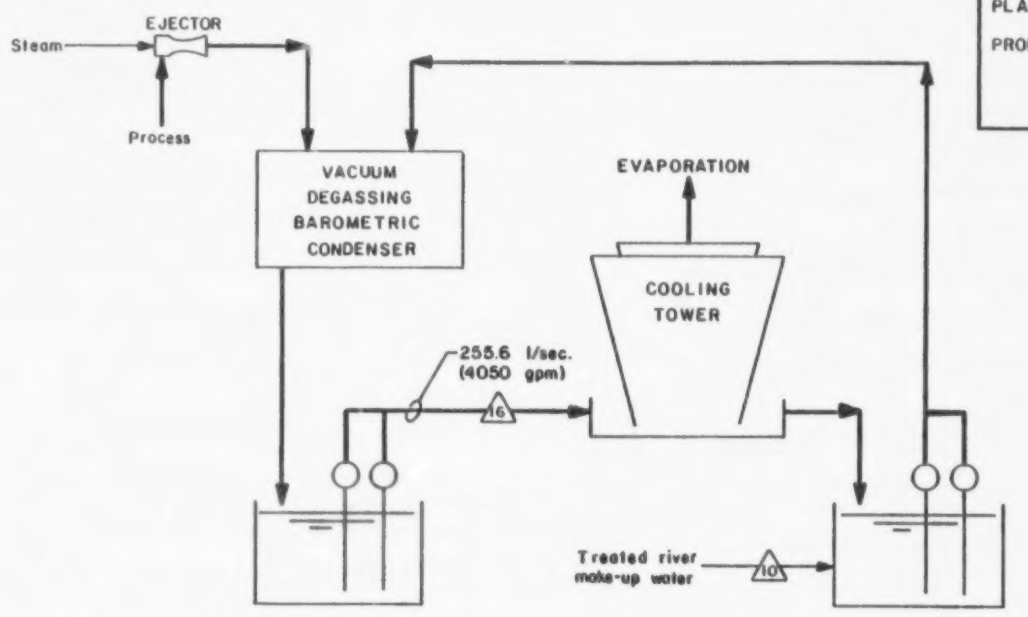
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
VACUUM DEGASSING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-3

PROCESS: VACUUM DEGASSING

PLANT: E

PRODUCTION: 192.3 metric tons steel/day
(212 tons steel/day)


EJECTOR
Steam
Process
VACUUM DEGASSING BAROMETRIC CONDENSER
EVAPORATION
COOLING TOWER
255.6 l/sec.
(4050 gpm)
16
Treated river make-up water
10

△ Sampling point

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

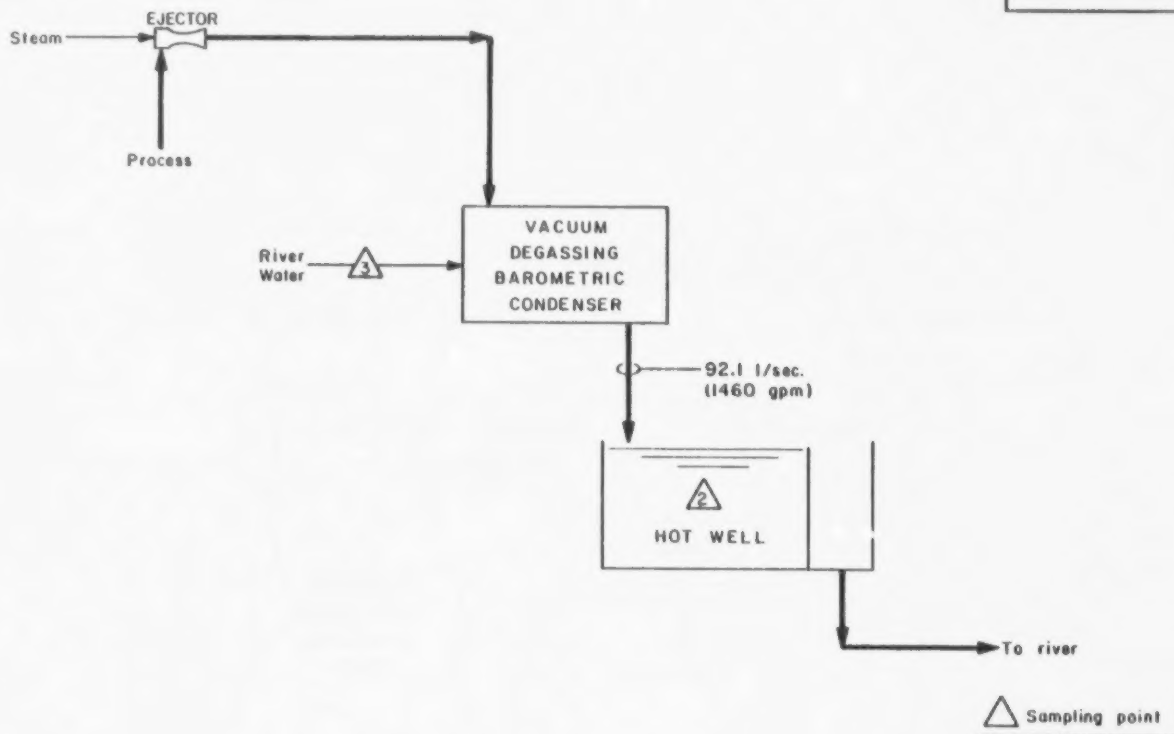
Dwn. 2/15/79

FIGURE VII-4

PROCESS: Vacuum Degassing

PLANT: G

PRODUCTION: 349.2 metric tons steel/day
(385 tons steel/day)


Steam
EJECTOR
Process
River Water
3
VACUUM DEGASSING BAROMETRIC CONDENSER
92.1 l/sec.
(1460 gpm)
2
HOT WELL
To river
Sampling point

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

Dwn. 2/14/79

FIGURE VII-5

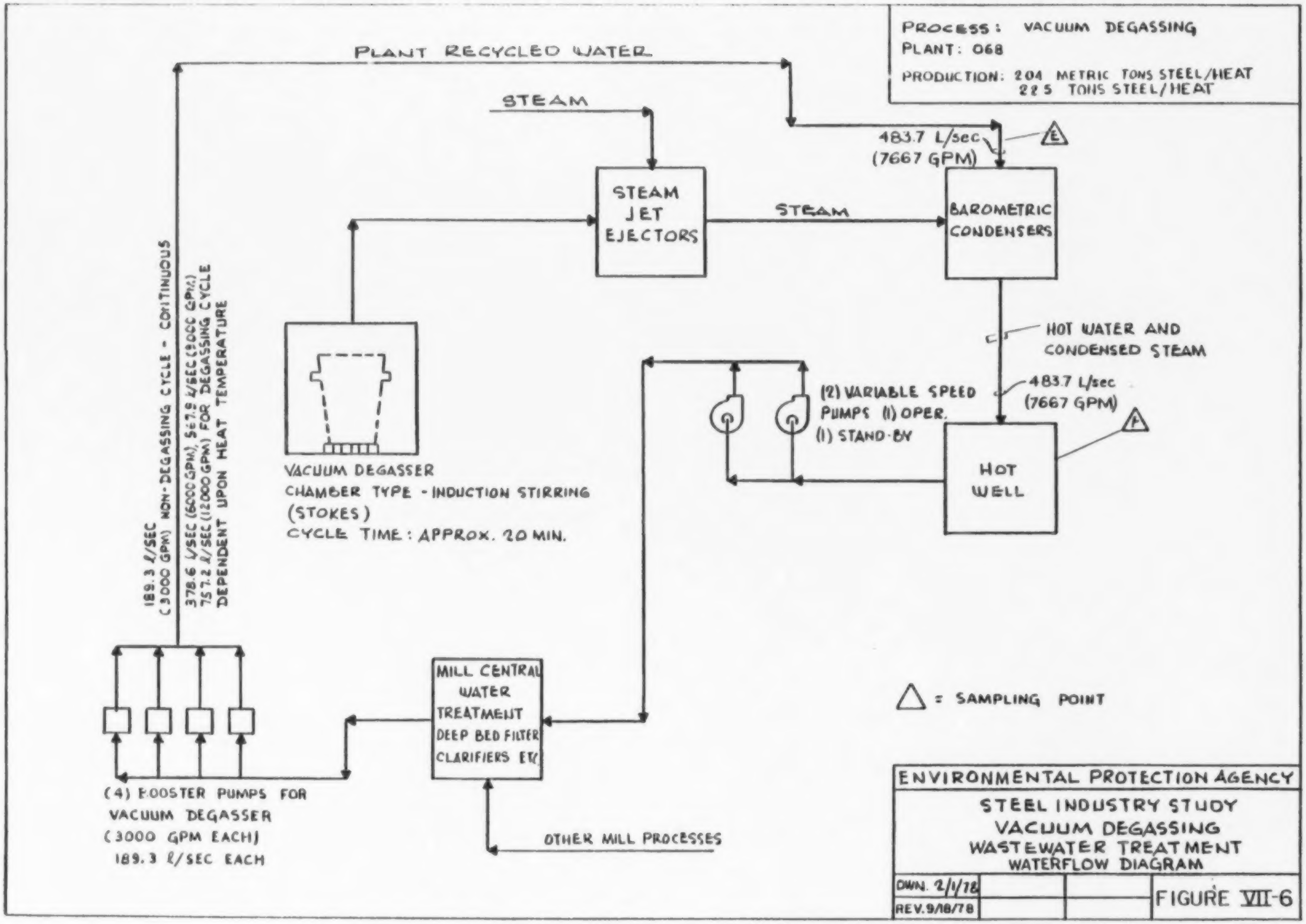

PROCESS: VACUUM DEGASSING
PLANT: 068
PRODUCTION: 204 METRIC TONS STEEL/HEAT
225 TONS STEEL/HEAT
PLANT RECYCLED WATER
STEAM
STEAM JET EJECTORS
STEAM
483.7 L/sec (7667 GPM)
E
BAROMETRIC CONDENSERS
HOT WATER AND CONDENSED STEAM
483.7 L/sec (7667 GPM)
F
HOT WELL
(2) VARIABLE SPEED PUMPS (1) OPER. (1) STAND-BY
VACUUM DEGASSER
CHAMBER TYPE - INDUCTION STIRRING
(STOKES)
CYCLE TIME: APPROX. 20 MIN.
189.3 ℓ/SEC
(3000 GPM) NON-DEGASSING CYCLE - CONTINUOUS
378.6 L/SEC (6000 GPM), 567.9 L/SEC (9000 GPM)
757.2 ℓ/SEC (12000 GPM) FOR DEGASSING CYCLE
DEPENDENT UPON HEAT TEMPERATURE
MILL CENTRAL WATER TREATMENT DEEP BED FILTER CLARIFIERS ETC
OTHER MILL PROCESSES
(4) BOOSTER PUMPS FOR VACUUM DEGASSER
(3000 GPM EACH)
189.3 ℓ/SEC EACH
△ = SAMPLING POINT
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
VACUUM DEGASSING
WASTEWATER TREATMENT
WATERFLOW DIAGRAM
DWN. 2/1/78
REV. 9/18/78

FIGURE VII-6

VACUUM DEGASSING SUBCATEGORY

SECTION VIII

COST, ENERGY, AND NONWATER QUALITY IMPACTS

Introduction

This section presents the estimated costs to be incurred in the application of the alternative treatment systems for the vacuum degassing subcategory. The analysis also considers the energy requirements, the nonwater quality impacts, and the techniques, magnitude, and costs associated with the application of the alternative treatment systems. In addition, this section addresses the wastes generation rates, the BCT cost comparison, and the consumptive use of water for the alternative systems.

Actual Costs Incurred by the Plants Sampled or Solicited for this Study

The water pollution control costs supplied by the industry for vacuum degassing operations sampled during this study or responding to the D-DCPs, are presented in Table VIII-1. These costs have been updated, from the then current year cost data to July 1, 1978 dollars. In several instances, the costs reported by the industry represented total expenditures for central treatment systems. Where possible, these costs were apportioned to vacuum degassing wastewaters, however, this could not be done in all cases.

The Agency compared the capital cost data reported by the industry with the estimated costs presented herein. The Agency made this comparison to insure that its cost estimates for the treatment models are sufficient to cover site-specific, retrofit, and other incidental costs associated with the systems. A summary of costs reported by the industry (refer to Table VIII-1) and the estimated model expenditures (as factored on the basis of production from the model costs) follows:

Plant No.	Actual Costs	Estimated Costs
0088A	$ 367,900	$ 411,000
0584F	879,000	2,827,000
0684E	1,711,800	1,790,000
0856F	109,800	113,000
0868B	324,200	1,306,000
TOTAL	$3,392,700	$6,447,000

In all instances, the Agency's estimated costs are greater than the actual costs reported by industry. The most noteworthy comparison, however, is the comparison of total costs, as this reflects upon the applicability of the cost of compliance for the entire subcategory. As the actual costs are significantly less than the estimated costs, the Agency concludes that the estimated costs are sufficiently generous to cover the various site-specific and other incidental costs. In fact, the above data indicate the Agency may be significantly overstating costs for this subcategory. The cost estimate review in Volume I provides further verification of the appropriateness of the treatment model costs.

Control and Treatment Technologies (C&TT) Recommended for Use in the Vacuum Degassing Subcategory

A summary of the wastewater treatment components considered for development of BPT and BAT effluent limitations is presented in Table VIII-2. It should be noted that the proposed limitations will not require the installation of these components, as any treatment system or operating practice which achieves the proposed effluent limitations is adequate. The following items are described in Table VIII-2.

1. Status and reliability
2. Problems and limitations
3. Implementation time
4. Land requirements
5. Environmental impacts other than water
6. Solid waste generation

Cost, Energy, and Nonwater Quality Impacts

General Introduction

The installation of BPT model and BAT, NSPS, PSES, and PSNS alternative wastewater treatment systems will require additional funding (both investment and operating) and energy requirements. Costs and energy requirements were estimated on the basis of the alternative treatment systems developed in Sections IX through XIII of this report and are presented in the tables and text of this section. This section also presents the air pollution, water consumption, and solid waste disposal requirements which may result from compliance with the proposed limitations.

Estimated Costs for the Installation of Pollution Control Technologies

A. Costs Required to Achieve the Proposed BPT Limitations

As a first step in estimating the cost of complying with the proposed limitations, the Agency developed a treatment model upon which cost estimates could be based. The model size (tons/day) was based upon the average production capacity for all vacuum degassing operations. The treatment model applied flow was also based on the average of existing plants. The components and effluent flow discusssed in Sections IX and X were incorporated to complete the development of the treatment model. The Agency then developed the unit costs for each treatment model component. Table VIII-3 presents the estimated capital and annual costs for the BPT model treatment system. The Agency determined the capital requirements needed to achieve the proposed BPT limitations by applying the treatment component model costs, adjusted for size, to each vacuum degassing operation. For costing purposes, the Agency assumed that all vacuum degassing operations generate process wastewaters. To assess the cost of the proposed limitations upon the industry, the Agency estimated the expenditures which will be required to bring vacuum degassing operations from current (January 1, 1978) treatment levels to the BPT model treatment level. Table VIII-4 summarizes the estimated in-place and required expenditures for each vacuum degassing operation. The estimated capital requirement of the proposed BPT limitations for this subcategory is 20.4 million dollars, while the associated estimated annual cost is 7.65 million dollars.

B. Costs Required to Achieve the Proposed BAT Limitations.

The Agency considered two alternative treatment systems for vacuum degassing operations. The rationale for selecting, and additional details regarding these alternatives, are discussed in Section X. The additional investment and annual expenditures involved in applying each of the BAT treatment alternatives to the BPT model treatment system are presented in Table VIII-5. The Agency determined the additional capital and annual costs for the subcategory by multiplying the unit costs for each component by the number of vacuum degassing operations requiring each component. The estimated investment and annual costs for each treatment alternative for the vacuum degassing subcategory follow.

BAT Alternative	Investment Costs In-Place	Investment Costs Required	Annual Costs
No.1	$64,000	$1,024,000	$200,600
No.2	$64,000	$2,180,000	$431,800

C. BCT Cost Comparison

As shown in Table VIII-6, the BCT treatment system fails the BCT cost test. Refer to Section XI for a review of the applicability of the BCT cost test to this treatment model.

D. NSPS Costs

The Agency developed two alternative treatment systems for those new vacuum degassing facilities constructed after the proposal of the New Source Performance Standards. The NSPS alternative treatment systems are the same as the BAT alternative treatment systems. The NSPS treatment model costs are presented in Table VIII-7.

E. Pretreatment Costs

Pretreatment standards apply to those plants which continue or elect to discharge their wastewaters to POTW systems. The model pretreatment system is the same as the BPT/BAT Alternative No.1 treatment system. The pretreatment system provides for reduction in effluent flow and the removal of toxic metals. Refer to

Section XIII for additional information pertaining to pretreatment standards. The model costs for the pretreatment system are the same as the costs for the NSPS No.1 system (refer to Table VIII-7).

Energy Impacts

Moderate amounts of energy will be required by the alternative treatment systems for the vacuum degassing subcategory. The major energy expenditures for the subcategory will be required for the BPT model treatment system, while the BAT treatment alternatives require relatively minor additional energy expenditures. This relationship reflects the incorporation of recycle and cooling tower technology (the primary energy consumers) at BPT. Energy requirements at NSPS and pretreatment will be similar to the total corresponding BPT/BAT systems.

A. Energy Impacts at BPT

The estimated energy requirement for the proposed BPT limitations is based upon the assumption that all vacuum degassing operations will install treatment systems similar to that of the treatment model with flows similar to that of the model. On this basis, the energy use for the BPT model treatment system for all vacuum degassing operations will be 35.5 million kilowatt hours of electricity per annum. This estimate represents 0.06% of the 57 billion kilowatt hours of electricity used by the steel industry in 1978.

B. Energy Impacts at BAT

The estimated energy requirements for the proposed BAT limitations are based on the same assumptions noted above for BPT. The estimated energy requirements, and their relationship to the 1978 industry power use, needed to upgrade from BPT to the two BAT treatment levels follow:

BAT Alternative	kwh per Year	% of Industry Usage
No.1	272,000	0.0005
No.2	952,000	0.002

These requirements are justified in relation to total industry use. In addition, the Agency concludes that the benefits of pollution control justify the minor impacts associated with energy consumption.

C. Energy Impacts for NSPS and Pretreatment

The energy requirements for the NSPS, PSNS, and PSES alternative treatment systems follow:

Model	kwh per Year
NSPS-1	1.05 million
NSPS-2	1.07 million
PSNS, PSES	1.05 million

The Agency did not estimate total impacts for NSPS and PSNS treatment systems since projections of future additions in this subcategory have not been made as part of this study. The PSES energy consumption is included in the BPT and BAT totals.

Nonwater Quality Impacts

In general, the Agency believes that the nonwater quality impacts associated with the proposed limitations are minimal. The three impacts which the Agency evaluated were air pollution, solid waste disposal, and water consumption.

A. Air Pollution

The use of cooling towers in the BPT model treatment system will result in the generation of water vapor plumes. However, these plumes should not contain any significant levels of particulates or volatile organics. As the Agency does not expect any other air pollution impacts to occur as a result of compliance with the proposed BPT limitations, it does not expect any significant air pollution impacts to occur.

Sulfide addition is incorporated in the BAT Alternative No.2 treatment system. In the event of treatment process control upsets, the atmospheric discharge of sulfides could occur. However, as vacuum degassing wastewaters are not typically acidic the possibility of atmospheric sulfide discharges, which are aggravated at an acidic pH, would be reduced. Also, atmospheric sulfide discharges could be reduced by using a ferrous sulfide slurry as the sulfide source for toxic metals precipitation.

However, as the Agency has selected BAT Alternative No.1 as the proposed BAT model treatment system (refer to Section X). The Agency believes that compliance with the proposed BAT limitations will have no adverse impact with respect to air pollution.

B. Solid Waste Disposal

The treatment steps incorporated in the BPT model and BAT alternative treatment systems will generate moderate quantities of solid wastes, consisting of the solids removed from the process. A summary of the solid waste generation rates for all vacuum degassing operations for the BPT and BAT alternative treatment systems follows.

Treatment Level	Solid Waste Generation for the Subcategory (Tons/Year)
BPT System	2610
BAT No.1	54.4
BAT No.2	61.1

As shown above, a moderate amount of solid wastes is generated by the BPT model treatment system, while the BAT alternative treatment systems generate minor incremental amounts of solid wastes. These solids, which are comprised principally of metal oxides (primarily iron), will require proper disposal.

The estimated amounts of solid wastes generated by the model NSPS, PSNS, and PSES systems follow.

Treatment Level	Solid Waste Generation for the Treatment Model (Tons/Year)
NSPS-1	78
NSPS-2	78
PSES, PSNS	78

As noted previously in this section, the NSPS, PSNS, and PSES alternative treatment systems are the same as the BPT/BAT treatment systems. The solid wastes generated at the NSPS, PSNS, and PSES levels are of the same nature and present the same disposal requirements as those for BPT and BAT.

C. Water Consumption

In the vacuum degassing subcategory, cooling towers are components of the BPT, BAT, NSPS, PSNS, and PSES alternative treatment systems. Cooling towers, which are used to reduce system heat loads and thus permit higher recycle rates, result in some degree of water consumption as a consequence of evaporation. Because the Agency previously received comments that the water consumed by evaporation in these cooling devices may result in adverse environmental impacts for plants in arid or semi-arid areas, the Agency analyzed the degree of water consumption. As discussed below in greater detail, the Agency found the water loss to be minimal. Since this degree of consumption is minimal, plants in all geographic regions could install these cooling devices if needed to achieve the proposed effluent limitations and standards. High recycle rates in arid or semi-arid regions will also serve to minimize surface and subsurface water withdrawals.

The analysis of this issue detailed the type of cooling devices in use at vacuum degassing operations and the evaporation rates for the devices in use, and quantified the volume of water which would be consumed in achieving the proposed BPT and BAT limitations. The Agency estimates that the total raw waste flow for vacuum degassing operations is 57.1 MGD, of which 0.83 MGD is presently consumed in existing cooling devices. In order to achieve the proposed BPT and BAT effluent limitations, the additional water consumption for the subcategory would amount to 0.13 MGD or 0.23% of the total volume applied. The impact of the consumptive use of water is minimal, especially since these cooling devices allow higher recycle rates, thus significantly reducing the volumes of water used in and discharged from the process. It should also be noted that water condensed from the steam used in the degassing process will replace at least a portion of the water consumed in the treatment process.

Summary of Impacts

In summary, the Agency concludes that the pollutant load reduction benefits described below for the vacuum degassing subcategory justify any adverse energy and nonwater quality environmental impacts.

	Effluent Loads (Tons/Year)		
	Raw Waste	Proposed BPT	Proposed BAT
Flow, MGD	57	1	1
TSS	6950	78	23
Toxic Metals	976	1.8	0.7

TABLE VIII-1

EFFLUENT TREATMENT COSTS
VACUUM DEGASSING

(All costs are expressed in July, 1978 Dollars)

Plant Code Reference Code	AC 0584F Original Survey	AD 0868B Original Survey	- 0088A D-DCP	- 0684E D-DCP	- 0856F D-DCP
Initial Investment	$879,002	$324,244	$367,864	$1,711,777	$109,728
Annual Costs					
Cost of Capital	37,797(1)	13,943(1)	15,818(1)	73,606(1)	4,718(1)
Depreciation	87,900(2)	32,424(2)	36,786(2)	171,178(2)	10,973(2)
Oper. & Maint.	67,156	89,301	-	-	-
Energy & Power	Incl. Above	Incl. Above	-	-	-
Chemical Costs	-	-	-	-	-
Other (Sludge, etc.)	-	-	-	-	-
TOTAL	$192,853	$135,668	-	-	-
$/Ton	0.081	0.338	-	-	-
$/1000 Gal. Treated	0.092	1.728	-	-	-

---

(1) Cost of capital was calculated by using the following formula: (0.043) x (initial investment).
(2) Depreciation was calculated by using the following formula: (0.10) x (initial investment).

-: Insufficient data.

NOTE: No effluent treatment costs were available for Plants E, G, 062, 065, and 068.

TABLE VIII-2

CONTROL AND TREATMENT TECHNOLOGIES
VACUUM DEGASSING SUBCATEGORY

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
A. Scale Pit - Using a scale pit or classifier, this step provides the initial point of suspended solids load reduction. This reduction is accomplished via gravity sedimentation.	Widely used in this subcategory and in similar applications for other subcategories and industries.	Accumulated solids must be periodically removed. Hydraulic overloads should be minimized.	6 to 8 months	20' x 30'	The solids which accumulate must receive proper disposal.	The treatment model solid waste generation rate, on the basis of dry solids, for this step is 0.35 lb/ton (420 lb/day, 96.7 tons/year) for the model. These solids consist primarily of the metal oxides which comprise the dusts generated during the degassing process.
B. Cooling Tower - Used to reduce the heat load of the wastewaters prior to recycle.	Used in several vacuum degassing operations as a means of facilitating wastewater recycle. Also widely used in other subcategories and industries for the purpose of heat load reduction.	The potential exists for scaling and plugging due to the increased dissolved solids concentrations associated with cooling and recycle operations. In addition, biological fouling must be controlled.	18 to 20 months	30' x 30'	Any solids which may accumulate in the cooling tower must receive proper disposal. Care must be exercised in the selection and use of chemicals to control fouling.	Virtually nil.
C. Recycle - Recycle a large portion of the cooling tower effluent back to the vacuum degassing operation.	Demonstrated in this subcategory (refer to Section X) as a means of attaining the treatment model effluent flow.	The potential exists for scaling and plugging due to the increased dissolved solids concentrations associated with recycle operations.	12 to 14 months	20' x 30'	None	None

TABLE VIII-2
CONTROL AND TREATMENT TECHNOLOGIES
VACUUM DEGASSING SUBCATEGORY
PAGE 2

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
D. Filtration - Filters are used to provide additional suspended solids removal capability.	Used in several vacuum degassing operations. In addition, the capabilities of this technology are well demonstrated in other subcategory and other industry wastewater treatment operations.	Hydraulic overloads must be controlled. Poor backwashing will impede efficient filter operation.	15 to 18 months	30' x 40'	The backwash solids must receive proper disposal.	The backwash solids represent an additional solids generation, on a dry solids basis, of 0.0073 lb/ton (8.8 lb/day, 1.6 tons/year) for the model. The backwash solids are similar in nature to the solids removed in Step A.
E. Sulfide Precipitation - A sulfide source is added to the wastewater stream to form metallic sulfide precipitates which are subsequently removed via filtration.	Used in various industrial wastewater treatment operations for the purpose of providing additional toxic metals removal capabilities.	Care must be exercised in the handling and use of the feed solutions. Tight treatment process control is needed.	6 months	10' x 10'	The resultant metal sulfide precipitates require proper disposal. Sulfide odors can result if inadequate treatment process control is provided.	The metal sulfide precipitates are removed by the filtration step.

TABLE VIII-3

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory: Vacuum Degassing
: Carbon, Specialty

Model Size-TPD : 1200
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	A	B	C	Total
Investment $ x 10^{-3}	95	627	394	1116
Annual Cost $ x 10^{-3}				
Capital	4.1	27.0	16.9	48.0
Depreciation	9.5	62.7	39.4	111.6
Operation & Maintenance	3.3	21.9	13.8	39.0
Sludge Disposal	0.4	-	-	0.4
Energy & Power(1)	-	26.1	8.2(2)	26.1
TOTAL	17.3	137.7	70.1(2)	225.1

Effluent Quality(3)	Raw Waste Load	BPT Effluent Level
Flow, gal/ton	1400	25
pH (Units)	6-9	6-9
Suspended Solids	80	50
Manganese	10	6.0
119 Chromium	1.0	0.35
120 Copper	0.20	0.10
122 Lead	5.0	0.35
124 Nickel	0.03	0.030
128 Zinc	5.0	0.35

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) All values are expressed in mg/l unless otherwise noted.

KEY TO C&TT STEPS

A: Scale Pit
B: Cooling Tower
C: Recycle 98%

TABLE VIII-4

BPT CAPITAL COST TABULATION
7/1/78 DOLLARS x 10^{-3}
BASIS: FACILITIES IN PLACE AS OF 1/1/78

Subcategory: Vaccum Degassing
: Carbon

Plant Code	TPD	C&TT Step A	C&TT Step B	C&TT Step C	C&TT Step In Place	C&TT Step Required	C&TT Step Total
0060	4,500	210	-	869	1,079	0	1,079
0112B	1,860	123	816	512	0	1,451	1,451
0496	1,600	-	-	468	468	0	468
0584F	6,554	263	1,737	1,090	2,827	263	3,090
0696A	800	74	492	309	0	875	875
0856F	1,600	113	745	468	113	1,213	1,326
0868B	1,560	111	734	461	1,306	0	1,306
					5,904	3,802	9,595

TABLE VIII-4
BPT CAPITAL COST TABULATION
7/1/78 DOLLARS x 10^{-3}
BASIS: FACILITIES IN PLACE AS OF 1/1/78
PAGE 2

Subcategory: Vaccum Degassing
: Specialty

Plant Code	TPD	C&TT Step A	B	C	In Place	Required	Total
0060D	3,000	164	1,086	566-116	730	1,202	1,932
0060F	1,100	90	595	373	0	1,058	1,058
0060J	120	24	158	99	0	281	281
0088A	900	80	528	331	411	528	939
0112	450	53	348	218	0	619	619
0168	450	53	348	218	0	619	619
0240A	1,100	90	595	373	0	1,058	1,058
0248B	1,600	-	-	468	468	0	581
0424A	63	16	107	67	0	190	190
0436	350	45	299	188	0	532	532
0576	260	38	251	157	0	446	446
0576A	450	53	348	218	0	619	619
0684E	2,640	152	1,006	632	1,790	0	1,790
0684H	1,200	95	627	394	0	1,116	1,116
0684U	360	46	305	191	0	542	542
0724A	450	53	348	218	0	619	619
0776E	150	27	180	113	0	320	320
0796A	2,496	147	923	611	0	1,584	1,731
0796C	120	24	158	99	0	281	281
0804A	150	27	180	113	0	320	320
0804B	210	33	220	30-108	63	328	391
0856H	960	83	549	344	0	976	976
0856R	340	45	294	185	0	524	524
0896	50	14	93	58	0	165	165
0946A	3,480	180	1,188	745	0	2,113	2,113
					*3,462	*16,040	*19,502

---

*: Total does not include confidential plants.

Note: Underlined costs represent facilities in place; where two figures appear in the same column, the underlined portion is in place, the nonunderlined portion remains to be installed.

C & TT Legend

A: Primary Scale Pit
B: Cooling Tower
C: Recycle

TABLE VIII-5

ALTERNATIVE BAT MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory: Vacuum Degassing
: Carbon/Specialty

Model Size-TPD : 1200
Oper. Days/Year: 365
Turns/Day : 3

C&TT Steps	Alternative 1		Alternative 2		
	D	Total	D and	E	Total
Investment $ x 10^{-3}	32	32		34	66
Annual Costs, $ x 10^{-3}					
Capital	1.4	1.4		1.5	2.9
Depreciation	3.2	3.2		3.4	6.6
Operation & Maintenance	1.1	1.1		1.2	2.3
Energy & Power(1)	0.2	0.2		0.5	0.7
Chemical Costs	-	-		0.2	0.2
TOTAL	5.9	5.9		6.8	12.7

Wastewater Parameters	BAT Feed Level	BAT No.1 Effluent Level	BAT No.2 Effluent Level
Flow, gal/ton	25	25	25
pH	6-9	6-9	6-9
Concentrations, mg/l			
Suspended Solids	50	15	15
119 Chromium	0.35	0.10	0.10
120 Copper	0.10	0.10	0.10
122 Lead	0.35	0.10	0.10
124 Nickel	0.030	0.030	0.030
128 Zinc	0.35	0.10	0.10

---

(1) Costs are all power unless otherwise noted.

KEY TO C&TT STEPS

D: Filtration

E: Sulfide Precipitation

TABLE VIII-6

RESULTS OF BCT COST TEST
VACUUM DEGASSING SUBCATEGORY

A. BCT Feed

Effluent Concentration of Conventional Pollutants = 50 mg/l
Flow = 0.03 MGD
Days/Year = 365
lbs/year of Conventional Pollutants Discharged = 4565

B. BCT-1 (Based upon BAT-1 and 2)

Effluent Concentration of Conventional Pollutants = 15 mg/l
Flow = 0.03 MGD
Days/Year = 365
lbs/year of Conventional Pollutants Discharged = 1369

lbs/year of Conventional Pollutants Removed via Treatment
4565-1369 = 3196

Annual Cost of BCT-1 = $5,900* $/lb = 1.85 FAIL
* Includes all C&TT Steps.

TABLE VIII-7

NSPS, PSES AND PSNS MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory: Vacuum Degassing

Model Size-TPD : 1200
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	NSPS Alternative 1 and the PSES & PSNS Model					NSPS Alternative 2		
	A	B	C	D	Total	A-D	E	Total
Investment $ x 10^{-3}	95	627	394	32	1148		34	1182
Annual Cost $ x 10^{-3}								
Capital	4.1	27.0	16.9	1.4	49.4		1.5	50.9
Depreciation	9.5	62.7	39.4	3.2	114.8		3.4	118.2
Operation & Maintenance	3.3	21.9	13.8	1.1	40.1		1.2	41.3
Sludge Disposal	0.4	-	-	-	0.4		-	0.4
Energy & Power(1)	-	26.1	8.2(2)	0.2	26.3		0.5	26.8
Chemical Costs	-	-	-	-	-		0.2	0.2
TOTAL	17.3	137.7	70.1(2)	5.9	231.0		6.8	237.8

Wastewater Parameters	Raw Waste Load	NSPS No.1, PSES and PSNS Effluent Level	NSPS No.2 Effluent Level
Flow, gal/ton	1400	25	25
pH	6-9	6-9	6-9
Concentrations, mg/l			
Suspended Solids	80	15	15
119 Chromium	1.0	0.10	0.10
120 Copper	0.20	0.10	0.10
122 Lead	5.0	0.10	0.10
124 Nickel	0.030	0.03	0.030
128 Zinc	5.0	0.10	0.10

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost as a credit is supplied for process water requirements.

KEY TO C&TT STEPS

A: Scale Pit
B: Cooling Tower
C: Recycle 98%
D: Filtration
E: Sulfide Precipitation

VACUUM DEGASSING SUBCATEGORY

SECTION IX

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

The Agency is proposing Best Practicable Control Technology Currently Available (BPT) limitations for vacuum degassing operations which are identical to those originally promulgated in June, 1974.[1] As the June, 1974 development document[2] described the methods used in developing the originally promulgated limitations, this section focuses on the achievability of the proposed limitations. A review of the treatment processes and effluent limitations associated with the vacuum degassing subcategory follows.

Identification of BPT

The original BPT model treatment system incorporated classifiers (i.e.,scale pits), recycle systems and cooling towers. Following sedimentation in a classifier, most of the process wastewaters are recycled, through a cooling tower, to the process. The remaining process wastewaters are discharged as a blowdown. Figure IX-1 depicts the treatment system described above.

The proposed BPT effluent limitations, which represent 30-day average values, are presented below:

	kg/kkg of Product (lb/1000 lb of Product)
Suspended Solids	0.0052
pH (Units)	6.0 to 9.0

The maximum daily effluent limitations are three times the average value presented above.

Rationale for BPT

Treatment System

As noted in Section VII, each of the BPT model treatment system components is in use at a number of vacuum degassing operations.

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[1] Federal Register; Friday, June 28, 1974; Part II, Environmental Protection Agency; Iron and Steel Manufacturing Point Source Category; Effluent Guidelines and Standards; Pages 24114-24133.

[2] EPA-440/I-74-024-a, Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steel Making Segment of the Iron and Steel Manufacturing Point Source Category.

Based upon widespread use in the industry, the Agency believes that the model treatment system is appropriate.

Justification of BPT Limitations

Table IX-1 presents sampled plant data that demonstrate the proposed BPT limitations are achievable. As only one of these plants employs a separate sedimentation step, the ability to achieve the proposed BPT limitations with treatment systems which differ from the BPT model is also demonstrated. The remaining sampled plants were unable to achieve the proposed BPT limitations due to the lack of, or insufficient, recycle. By reducing effluent flows to approximately the level incorporated in the BPT treatment model, these plants would be able to achieve the proposed BPT limitations. The data presented in Table IX-1 justify the proposed BPT limitations.

TABLE IX-1

JUSTIFICATION OF BPT LIMITATIONS VACUUM DEGASSING SUBCATEGORY

	Suspended Solids	pH	C&TT Components
Originally Promulgated BPT	0.0052	6-9	PSP,CT,RTP-98
Plants			
AD(0868B)	0.00021	6.8	PSP,FD(UNK)P, RTP98.8
E(0020B)	Zero Discharge	-	CT,RTP-100
G(0856B)	0.0020	6.4	OT
0584F(1)	0.000532	4.9	CT,RTP-98
0684E(1)	0.00297	8.4	FLO(2),FLL, FLP,CL,CT,RTP-99.6

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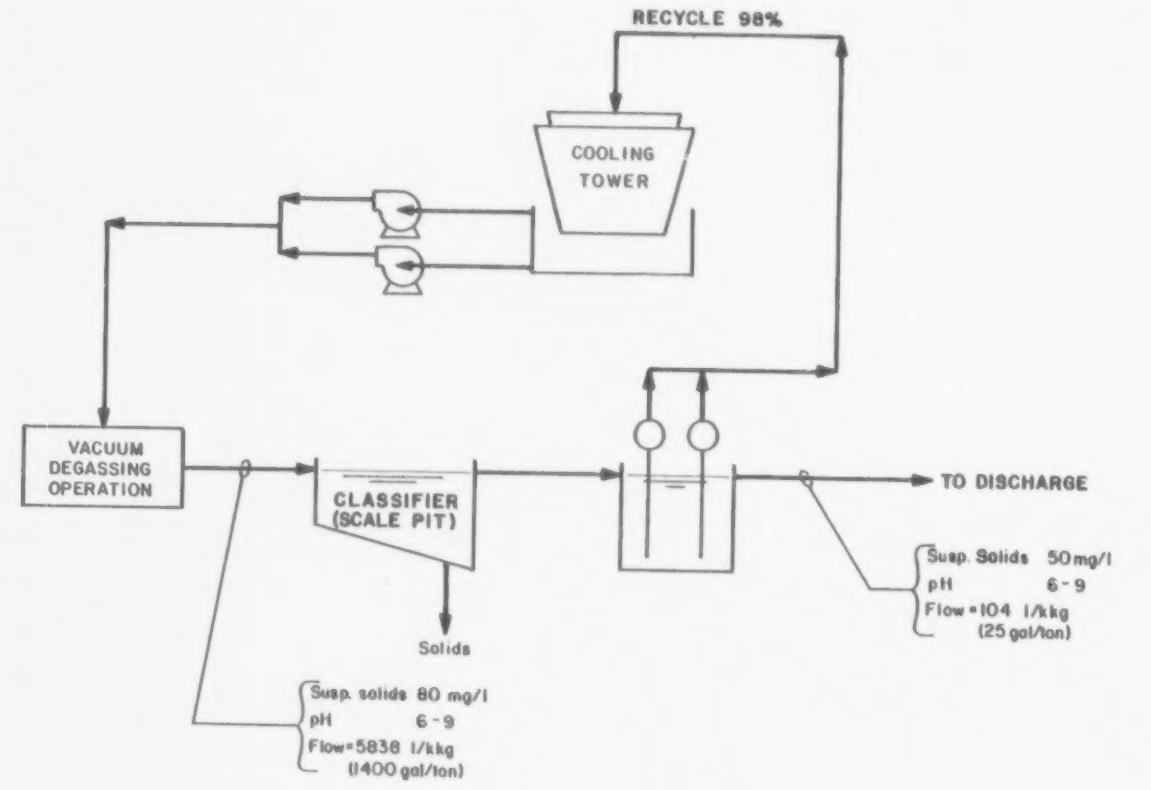
(1) Based on D-DCP analytical data.
(2) Flocculation with ferric chloride.


RECYCLE 98%
COOLING TOWER
VACUUM DEGASSING OPERATION
CLASSIFIER (SCALE PIT)
Solids
TO DISCHARGE
Susp. solids 80 mg/l
pH 6 - 9
Flow=5838 l/kkg
(1400 gal/ton)
Susp. Solids 50 mg/l
pH 6 - 9
Flow=104 l/kkg
(25 gal/ton)

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING
BPT MODEL

Dwn. 6/1/78

FIGURE IX-1

VACUUM DEGASSING SUBCATEGORY

SECTION X

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Introduction

This section identifies two BAT alternative treatment systems and the respective effluent levels considered by the Agency for the vacuum degassing subcategory. In addition, the rationale for selecting the treatment technologies, discharge flow rates, and effluent pollutant concentrations are presented. Finally, the selection of the BAT model treatment technologies which serve as the basis for the proposed BAT effluent limitations is reviewed.

Identificaton of BAT

Based upon the information contained in Sections III through VIII, the Agency developed the following treatment technologies (as add-ons to the BPT treatment system model) to serve as BAT alternative treatment systems for the vacuum degassing subcategory.

1. BAT Alternative No.1

   In the first BAT Alternative, filtration of the BPT treatment system blowdown of 25 gal/ton is provided to remove particulate toxic metals.

2. BAT Alternative No.2

   In this alternative, sulfide precipitation prior to the filtration step outlined above is provided. Sulfide precipitation techniques are capable of providing a higher degree of toxic metals removal.

Figure X-1 illustrates the BAT alternative treatment systems for the vacuum degassing subcategory. These treatment technologies are in use at one or more plants or demonstrated in other wastewater treatment applications, and are considered to be capable of attaining the respective proposed BAT effluent limitations.

The proposed BAT limitations are presented in Table X-1. Section VI presents the rationale for selecting those toxic metal pollutants considered for limitation. As noted in Volume I, treatment of those toxic pollutants found at high levels in the process wastewaters will result in treatment for those similar toxic pollutants found at lower levels. Although several toxic metal pollutants are found in vacuum degassing process wastewaters, the Agency is proposing limitations for only three toxic metals at the BAT, NSPS, PSNS, and PSES levels in this subcategory. The Agency's selection of those pollutants for which limitations and standards are being proposed is based upon the following considerations: the relative levels, loads, and environmental impacts of each pollutant; the ability of the selected toxic metal pollutants to serve as indicators of overall and toxic metals treatment performance; and, the need to develop practical monitoring requirements for the industry. While the Agency found other toxic metals in vacuum degassing wastewaters, compliance with the proposed limitations for the three toxic metals listed in Table X-1 will provide similar control of other toxic metals. Investment and annual costs for the BAT alternative treatment systems are presented in Table VIII-5.

Rationale for the Selection of the BAT Alternatives

The following discussion presents the rationale for selecting the BAT alternative treatment systems, determining the effluent flow rates, and determining the concentration levels of the limited pollutants.

Treatment Technologies

The treatment model applied and discharge flows (retained from the BPT level of treatment) are based upon a system recycle rate of 98%. Table X-2 summarizes the recycle rates of those vacuum degassing operations which provided useable data. Referring to this table, it should be noted that eight of the ten plants which used recycle systems (a total of fifteen plants provided enough information to determine the system operating mode) equalled or exceeded the 98% recycle rate. In fact, two of the plants with recycle systems operate with no discharge of process wastewater pollutants to navigable waters. The treatment system recycle rate is therefore well documented within this subcategory.

Filtration is included in both BAT alternative treatment systems in order to remove that portion of the toxic metals load entrained in suspended solids. Filtration is employed at two of the plants in this subcategory (0496 and 0868B) and has widespread use throughout the steel industry.

Sulfide precipitation is incorporated in the second BAT treatment alternative for the purpose of insuring optimum reductions in the levels of toxic metals. Although not employed in this subcategory, the effectiveness of this treatment technology has been demonstrated in the electroplating industry, in pilot studies and in wastewater treatment applications in other metals manufacturing operations.

Flows

The model applied and discharge flows (1400 gal/ton and 25 gal/ton respectively) developed for BPT are retained in the BAT treatment alternatives.

Wastewater Quality

Following are the average effluent concentrations incorporated in each BAT treatment alternative (the maximum values are enclosed in parentheses):

	BAT Alt. No.1	BAT Alt. No.2
Chromium, mg/l	0.10(0.30)	0.10(0.30)
Lead, mg/l	0.10(0.30)	0.10(0.30)
Zinc, mg/l	0.10(0.30)	0.10(0.30)

The development of these values is discussed below and presented in Appendix A of Volume I.

Toxic Metals

A. BAT Alternative 1

To determine the effluent concentrations for the toxic metal pollutants, analytical data from a variety of sources were evaluated. Long-term filtration system effluent analytical data from these plants were reviewed to determine the toxic metals removal capabilities of filtration systems used in similar wastewater treatment applications. In addition, a review of the analytical data for this subcategory indicated that the suspended solids contain most of the toxic metals load. Reference is made to Appendix A of Volume I for the derivation of performance standards for toxic metals.

B. BAT Alternative 2

As noted previously in this section, BAT Alternative 2 incorporates a sulfide precipitation system along with the filtration system provided in BAT Alternative 1. As sulfide precipitation technology has not been demonstrated on a full scale basis within this subcategory, the capabilities of this technology have been transferred from other metals manufacturing wastewater treatment applications. The toxic metals effluent levels which can be achieved with this treatment technology were developed on the basis of the data review presented in Volume I. As vacuum degassing process wastewaters contain a number of the same pollutants found in the wastewaters used in the data review and the dissolved metals and metal precipitates will behave in a similar manner, the transfer of the sulfide precipitation technology is appropriate. The data indicated that average toxic metals effluent concentrations of 0.10 mg/l could be attained after incorporation of this treatment technology.

Effluent Limitations for the BAT Alternatives

The effluent limitations for the BAT alternative treatment systems were calculated by multiplying the effluent flow of each alternative treatment system, and the respective concentrations of each toxic pollutant, and the appropriate conversion factors. Table X-1 presents the proposed effluent limitations for each treatment alternative.

Selection of a BAT Alternative

The Agency selected BAT Alternative No. 1 as the BAT model treatment system. The selection process involved reviewing the toxicity levels of each pollutant considered for limitation at BAT and the effluent levels of these pollutants in each treatment alternative. On the basis of these considerations, the Agency determined that BAT No. 1 provides the most significant benefits with regard to reductions in toxic pollutant effluent loads. Following is a summary of the effluent loads (tons/year) for this subcategory.

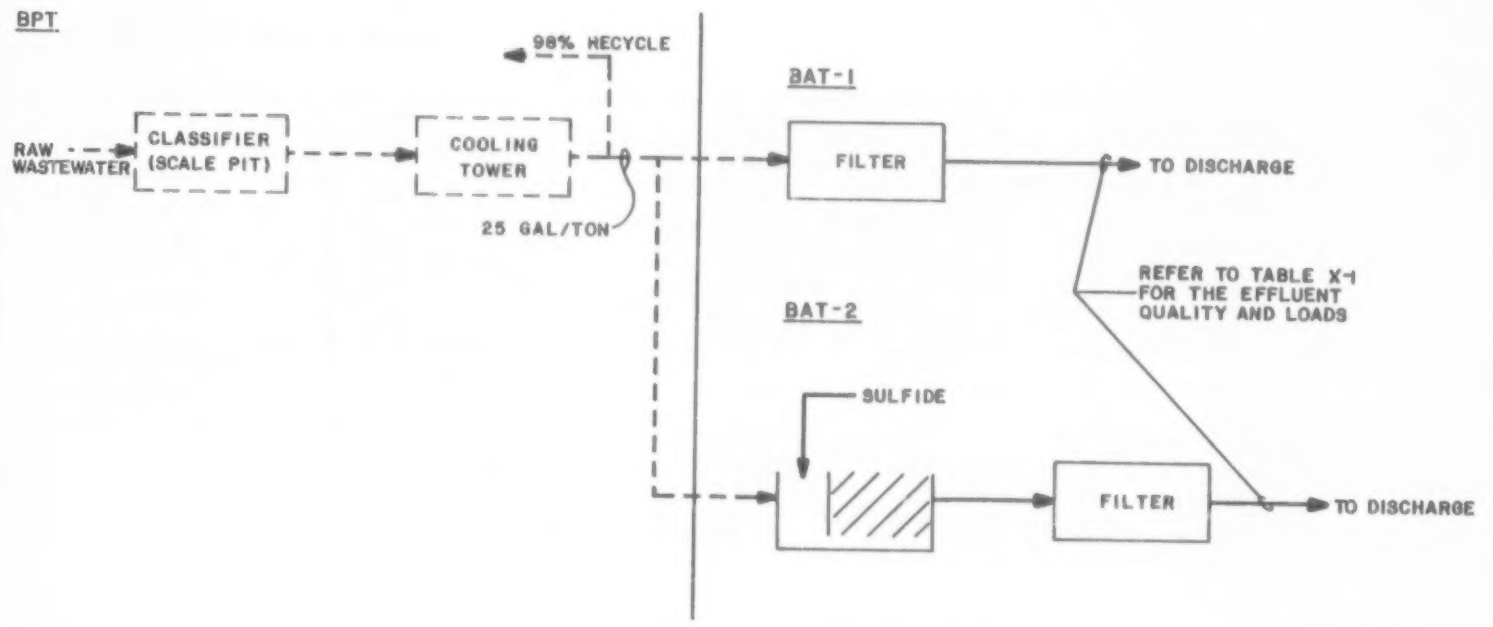
	Raw Waste	BPT Effluent	BAT No.1 Effluent	BAT No.2 Effluent
Toxic Metals	976	1.8	0.7	0.7
TSS	6950	78	23	23

The proposed BAT limitations are presented in Table X-1 under the heading of the first BAT treatment alternative.

TABLE X-I
BAT EFFLUENT LIMITATIONS GUIDELINES
VACUUM DEGASSING SUBCATEGORY

		BAT ALTERNATIVE I		BAT ALTERNATIVE 2	
		Concentration Basis (mg/l)	Effluent Limitations (kg/kkg of Product)	Concentration Basis (mg/l)	Effluent Limitations (kg/kkg of Product)
Discharge Flow (gal/ton)		25	——	25	——
Chromium	Ave.	0.10	0.000010*	0.10	0.000010
	Max.	0.30	0.000031*	0.30	0.000031
Lead	Ave.	0.10	0.000010*	0.10	0.000010
	Max.	0.30	0.000031*	0.30	0.000031
Zinc	Ave.	0.10	0.000010*	0.10	0.000010
	Max.	0.30	0.000031*	0.30	0.000031

* - Proposed BAT Effluent Limitations.


BPT
RAW WASTEWATER
CLASSIFIER (SCALE PIT)
COOLING TOWER
98% RECYCLE
25 GAL/TON
BAT-1
FILTER
TO DISCHARGE
REFER TO TABLE X-1 FOR THE EFFLUENT QUALITY AND LOADS
BAT-2
SULFIDE
FILTER
TO DISCHARGE

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING SUBCATEGORY
BAT TREATMENT MODEL

Dwn. 5/5/80

FIGURE X-1

VACUUM DEGASSING SUBCATEGORY

SECTION XI

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

Introduction

The 1977 Amendments added Section 301(b)(4)(E) to the Act, establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in Section 304(g)(4) - BOD, TSS, fecal coliform and pH - and any additional pollutants defined by the Administrator as "conventional." On July 28, 1978, EPA proposed that COD, oil and grease, and phosphorus be added to the conventional pollutant list (43 Fed. Reg. 32857). Only oil and grease was added.

BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. BCT requires that limitations for conventional pollutants be assessed in light of a new "cost-reasonableness" test, which involves a comparison of the cost and level of reduction of conventional pollutants from the discharge of POTWs to the cost and level of reduction of such pollutants from a class or category of industrial sources. As part of its review of BAT for certain "secondary" industries, EPA proposed methodology for this cost test. (See 43 Fed. Reg. 37570, August 23, 1978.)

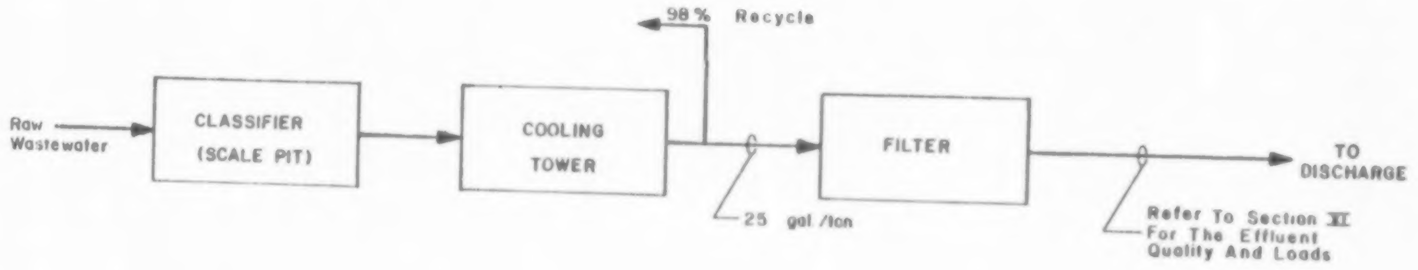
BCT Methodology

The BCT methodology is described in Volume I.

Development of BCT Limitations

The reference POTW treatment cost for the conventional pollutants is \$1.34/lb (all costs are based on 7/1/78 dollars). The BCT cost test (refer to Table VIII-6), indicated that the conventional pollutant treatment costs are \$1.85/lb for the BCT model treatment system, which includes filtration of the BPT effluent. Figure XI-1 illustrates the BCT model treatment system for this subcategory. Therefore, the BCT model treatment system did not pass the BCT cost test. Hence, the proposed BPT limitations for suspended solids are also proposed as the BCT limitations for suspended solids. Following are the proposed BCT effluent limitations for the vacuum degassing subcategory.

	Effluent Limitations (kg/kkg of Product)	
	30-Day Average	Daily Maximum
Suspended Solids	0.0052	0.0156
pH	Within the range 6.0 to 9.0	


Raw Wastewater
CLASSIFIER (SCALE PIT)
COOLING TOWER
98 % Recycle
25 gal /ton
FILTER
TO DISCHARGE
Refer To Section XI For The Effluent Quality And Loads

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING SUBCATEGORY
BCT TREATMENT MODEL

Dwn. 11/5/80

FIG. XI-1

VACUUM DEGASSING SUBCATEGORY

SECTION XII

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF NEW SOURCE PERFORMANCE STANDARDS

Introduction

A new source is defined as any source constructed after the proposal of new source performance standards (NSPS). The degree of effluent reduction achievable through the application of the best available demonstrated control technology (BADCT), processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants. While zero discharge is not being proposed at this time, the Agency is considering zero discharge and is soliciting comments on whether zero discharge can be universally applied to this subcategory.

NSPS Alternative 1

The first NSPS treatment alternative uses the BPT and BAT Alternative No. 1 treatment components discussed in Section IX and X. This system initially provides sedimentation of the raw process wastewaters in a classifier (or similar settling device). The major portion (98%) of the classifier effluent is recycled to the process through a cooling tower. The cooling tower is used to reduce the recycle system heat load. The system blowdown passes through a pressure filter prior to discharge.

NSPS Alternative 2

The NSPS Alternative 2 treatment system is identical to the system described above, with the exception that sulfide precipitation is incorporated prior to the filtration component. This system is similar to the BPT and the BAT Alternative 2 systems discussed in Section IX and X.

The NSPS treatment systems described above are depicted in Figure XII-1. The corresponding effluent levels and loads are presented in Table XII-1. Cost data for the treatment alternatives are presented in Table VIII-7.

Rationale for Selection of NSPS

The NSPS treatment alternatives for the vacuum degassing subcategory are similar to the BPT and BAT model treatment systems described in Sections IX and X. Therefore, the rationale presented in these sections is also applicable to new sources and is not repeated.

Both NSPS treatment alternatives for the vacuum degassing subcategory are addressed collectively in the following discussions.

Treatment Technologies

As noted in Section X, the use of filtration technology is documented not only within the steel industry, but also within the vacuum degassing subcategory. With the exception of sulfide precipitation, the other treatment technologies are also well demonstrated within the vacuum degassing subcategory. As discussed in Section X, sulfide precipitation has been successfully applied to the treatment of other metals manufacturing process wastewaters and is considered suitable for the treatment of the various steel industry process wastewaters as well. While, at this time, sulfide precipitation has not been demonstrated with pilot plant studies or through full scale demonstration in this subcategory, the components of the model treatment system are reliable and demonstrated methods of treatment and are, thus, appropriate for consideration in NSPS.

The resulting effluent wastewater quality for the NSPS alternatives are presented in Table XII-1. As noted in Section X, the critical pollutants and their respective effluent levels were based upon the capabilities of the various wastewater treatment technologies. The pollutants listed on Table XII-1 include only those pollutants for which BAT limitations are being proposed (refer to Section X for the factors considered in selecting these pollutants).

Flows

The applied and discharge flows developed for the BPT and BAT alternative treatment systems are applicable to both NSPS alternatives as well. Plants within this subcategory have demonstrated their ability to achieve effluent flows of 25 gal/ton (as provided in the treatment model) or less. The recycle rate of 98%, (as defined by the treatment model applied and discharge flows), is also demonstrated in the vacuum degassing subcategory.

Wastewater Quality

The effluent level (15 mg/l) for suspended solids in the various treatment alternatives was developed on the basis of a statistical review of long-term analytical data for several wastewater filtration operations. This review is detailed in Appendix A of Volume I. The particulate matter suspended in degassing process wastewaters will exhibit behavior basically similar to that of the solids in the wastewaters noted above when filtration technologies are employed for suspended solids removal. In the reference wastewaters and in the degassing wastewaters, the suspended solids are principally discrete particles which are amenable to removal by filtration. Refer to Volume I for a detailed review of the thirty-day average and daily maximum effluent concentrations development. Refer to Section X for discussions regarding the development of the toxic metals model effluent values.

Selection of NSPS Alternative

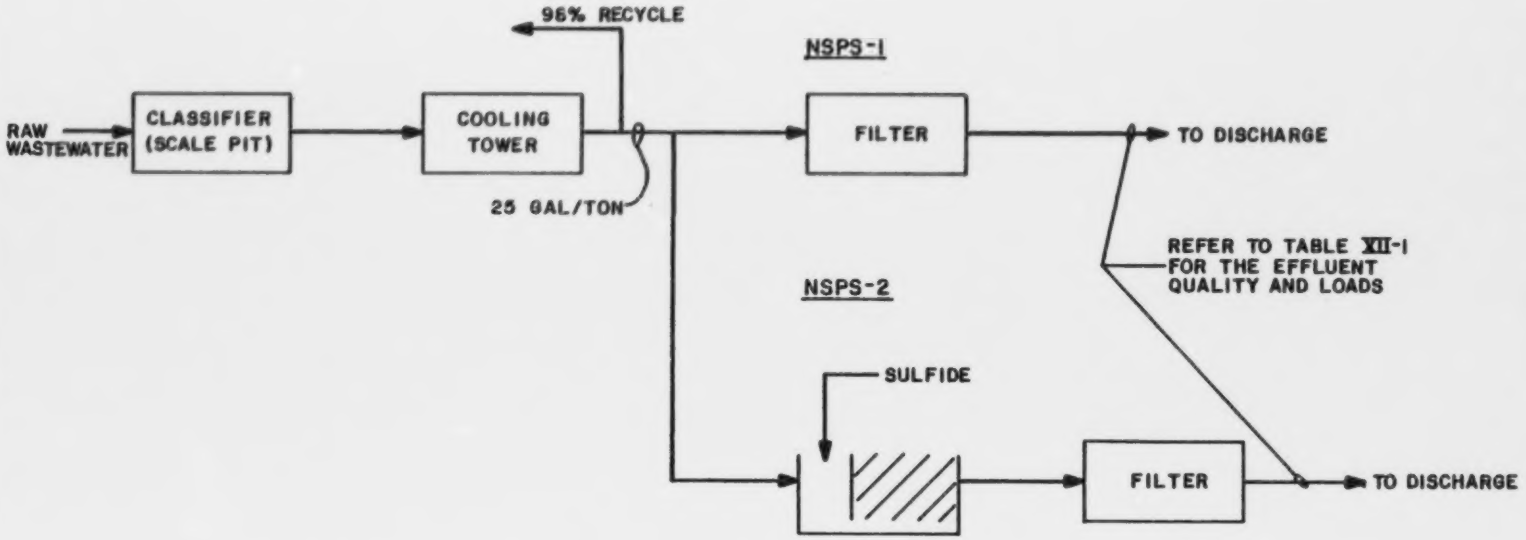
The Agency selected NSPS Alternative No. 1 as the NSPS model treatment system. This alternative was selected for the same reasons noted in the discussion in Section X regarding the selection of the BAT model treatment system.

The proposed NSPS effluent standards are presented in Table XII-1 in the column for the first NSPS treatment alternative.

TABLE XII - I
NEW SOURCE PERFORMANCE STANDARDS
VACUUM DEGASSING SUBCATEGORY

		NSPS ALTERNATIVE 1[*]		NSPS ALTERNATIVE 2	
		Concentration Basis (mg/l)	Effluent Standards (kg/kkg of Product)	Concentration Basis (mg/l)	Effluent Standards (kg/kkg of Product)
Discharge Flow (gal/ton)		25	——	25	——
Total Suspended Solids	Ave.	15	0.0016	15	0.0016
	Max.	40	0.0042	40	0.0042
pH		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0	
Chromium	Ave.	0.10	0.000010	0.10	0.000010
	Max.	0.30	0.000031	0.30	0.000031
Lead	Ave.	0.10	0.000010	0.10	0.000010
	Max.	0.30	0.000031	0.30	0.000031
Zinc	Ave.	0.10	0.000010	0.10	0.000010
	Max.	0.30	0.000031	0.30	0.000031

[*] - Proposed NSPS


96% RECYCLE
NSPS-1
RAW WASTEWATER
CLASSIFIER (SCALE PIT)
COOLING TOWER
FILTER
TO DISCHARGE
25 GAL/TON
REFER TO TABLE XII-1 FOR THE EFFLUENT QUALITY AND LOADS
NSPS-2
SULFIDE
FILTER
TO DISCHARGE

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING SUBCATEGORY
NSPS TREATMENT MODELS

Dwn.5/7/80

FIGURE XII-1

VACUUM DEGASSING SUBCATEGORY

SECTION XIII

PRETREATMENT STANDARDS FOR DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS

Introduction

This section discusses the control and treatment alternatives available for vacuum degassing operations which discharge wastewaters to a publicly owned treatment works (POTWs). No vacuum degassing operations currently discharge to POTWs. Separate consideration has been given to the pretreatment of vacuum degassing process wastewaters from new sources and from existing sources.

The general pretreatment and categorical pretreatment standards applying to vacuum degassing operations are discussed below.

General Pretreatment Standards

For detailed information on Pretreatment Standards refer to 43 FR 27736-27773, "General Pretreatment Regulations for Existng and New Sources of Pollution, (June 26, 1978). In particular, 40 CFR Part 403 describes national standards (prohibited and categorical standards), revision of categorical standards through removal allowances, and POTW pretreatment programs.

In establishing pretreatment standards for vacuum degassing operations, the Agency gave primary consideration to the objectives and requirements of the General Pretreatment Regulations. The General Pretreatment Regulations set forth general discharge prohibitions that apply to all non-domestic users of a POTW to prevent pass-through of pollutants, and municipal sludge contamination. The regulations also establish administrative mechanisms to ensure application and enforcement of prohibited discharge limits and categorical pretreatment standards. In addition, the Regulations contain provisions relating directly to the determination of and reporting on Pretreatment Standards.

POTWs are usually not designed to treat the toxic pollutants present in vacuum degassing process wastewaters. Instead, POTWs are designed to treat biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform bacteria, and pH. Whatever removal obtained by POTWs for toxic pollutants is incidental to the POTW's main function of conventional pollutant treatment. POTWs have, historically, accepted large amounts of many pollutants well above their capacity to treat them adequately. As the issue of municipal sludge use has become more important, pretreatment standards must address toxic and nonconventional pollutant removal, rather than transfer these pollutants to POTWs where many pollutants concentrate in the sludges.

Pretreatment standards for total suspended solids, oil and grease, and pH are not proposed because these pollutants, at the levels found after pretreatment in this subcategory, are compatible with POTW operations and can be effectively treated at POTWs.

Due to the presence of toxic pollutants in wastewaters from vacuum degassing operations, pretreatment must be provided to ensure that these pollutants do not interfere with, pass through, or otherwise be incompatible with POTW operations, or damage the treatment facilities. The following discussions identify the pretreatment alternatives considered for toxic pollutant removal, the rationale for these technologies, and finally, the development of a pretreatment system upon which the proposed categorical PSES and PSNS are based.

Identification of Pretreatment

The pretreatment model system developed for both existing and new sources are identical to the New Source Performance Standard Alternative No.1 model treatment system (refer to Section XII). Hence, the proposed Existing Source and New Source Pretreatment Standards (PSES and PSNS) are the same. Only the treatment system selected for use in developing the proposed BAT effluent limitations and NSPS is retained for use as a model pretreatment system. The selection of the pretreatment model system is based upon the same factors considered in selecting the BAT and NSPS alternatives (refer to Sections X and XII).

The principal goal of the pretreatment system is the treatment and removal of the toxic metal pollutants. In the case of vacuum degassing operations, a classifier is used to provide the initial reduction in toxic metal pollutant loads (as a result of removing those solids in which the toxic metals are entrained). The majority of the classifier effluent is then recycled to the process through a cooling tower, which provides a reduction in the recycled wastewater heat load. The remainder of the classifier effluent (25 gal/ton) is filtered prior to discharge. The recycle rate defined by the treatment model applied and discharge flows is 98%. As noted previously, the toxic metal pollutants, which are present in vacuum degassing wastewaters, are found primarily in the suspended particulate matter. Therefore, suspended solids control will result in a reduction in the toxic metal pollutant levels. For this reason, the Agency incorporated filtration in the PSES and PSNS model treatment system. Removal of suspended solids (and hence toxic metals) will correspondingly reduce the accumulation of toxic metals in the sludges generated by POTWs which receive these wastewaters.

Figure XIII-1 illustrates the pretreatment model system described above. Table XIII-1 presents the proposed PSNS and PSES standards. As noted previously, the pretreatment model system is identical to NSPS Alternative 1 and, as a result, reference can be made to the NSPS model cost data (Table VIII-7) for pretreatment cost information.

Rationale for the Selection of Pretreatment Technologies

The recycle rate incorporated in the pretreatment system was previously justified in Section X. Recycle is needed in vacuum degassing pretreatment systems in order to minimize the hydraulic impact of process wastewater discharges to POTWs. Excessive flows to a POTW must be restricted not only for reasons of physical limitations (i.e., hydraulics) but also for reasons of process limitations. The pretreatment model effluent flow (25 gal/ton) is the same as that of the BPT, BAT, and NSPS model treatment systems.

As noted previously, the toxic metal pollutants present in vacuum degassing wastewaters are found principally in the suspended particulate matter. As a result, control of suspended solids will produce a reduction in toxic metals levels. The Agency concluded that pretreatment standards for toxic metal pollutants are appropriate, as they can adversely affect a POTW in the following ways: (1) inhibit the POTW treatment process; (2) pass through the POTW during treatment; and, (3) contaminate the POTW sludges.

Various studies[3] have demonstrated that, in particular, three of the toxic metals (chromium, lead, and zinc) found in vacuum degassing wastewaters inhibit the biological treatment process when found at levels typical of vacuum degassing wastewaters. The use of filtration technology in the pretreatment system will ensure that the toxic metals present in the vacuum degassing wastewater discharge will not adversely affect the treatment process or pass through POTW systems.

Other studies[4] involving the electroplating industry (with similar levels of the same toxic metals) indicated that from fifty percent to ninety percent of the toxic metals entering a POTW will pass through the system. The possibility therefore exists that a POTW could discharge undesirable levels of toxic metals when accepting industrial process wastewaters.

The toxic metals, which do not pass through a POTW, are concentrated in the POTW sludges. Generally, land application is the most advantageous, yet least expensive, method of POTW sludge disposal as the sludge can be used to replace soil nutrients. However, excessive amounts of toxic metals in the sludges would inhibit plant growth thus rendering the sludge unfit for use as a soil nutrient supplement. In addition, these metals could enter either the plant or animal food chains, or they could leach into surface or groundwaters. For the above reasons, the control of toxic metal pollutant discharges to a POTW is essential.

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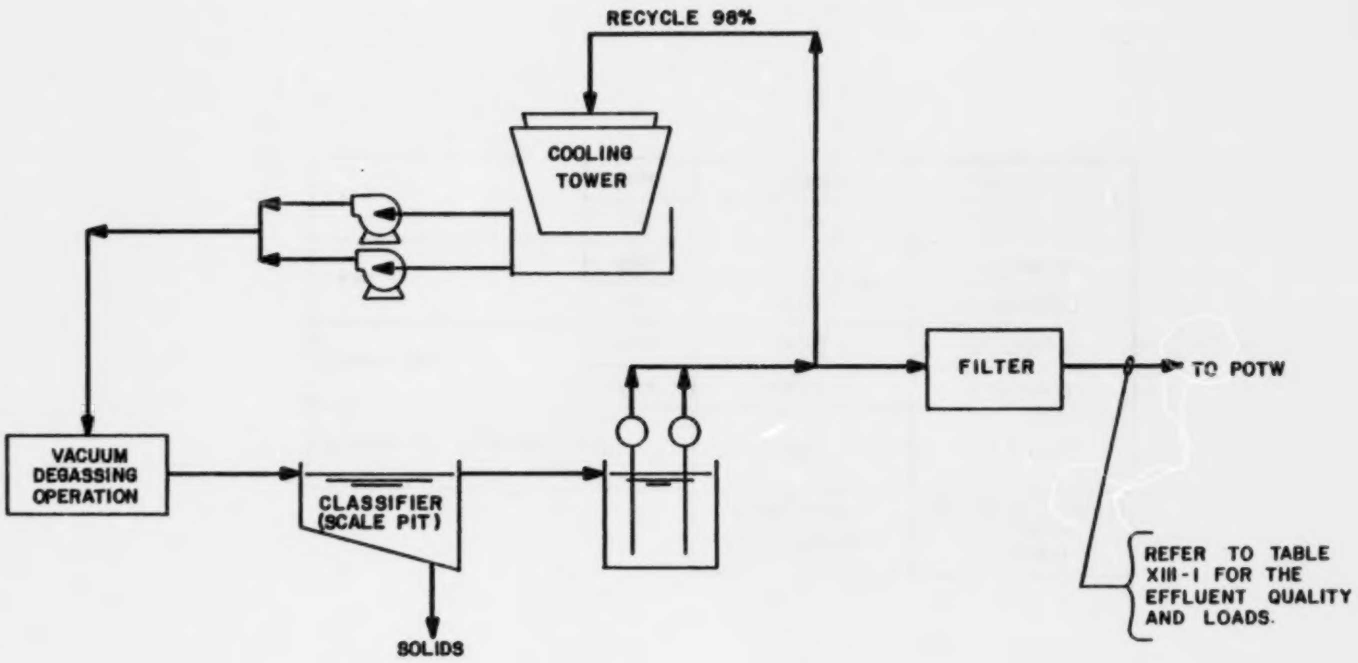
[3] EPA-430/9-76-017a, Construction Grants Program Information; Federal Guidelines, State and Local Pretreatment Programs.

[4] Federal Register; Friday, September 7, 1979; Part IV, Environmental Protection Agency; Effluent Guidelines and Standards; Electroplating Point Source Category; Pretreatment Standards for Existing Sources - Pages 52597-52601.

Table XIII-1 presents the proposed pretreatment standards for existing and new sources (PSES and PSNS).

TABLE XIII-1
PRETREATMENT EFFLUENT STANDARDS (Existing and New Sources)
VACUUM DEGASSING SUBCATEGORY

		Concentration Basis (mg/l)	Effluent Standards (kg/kkg of Product)
Discharge Flow(gal/ton)		25	———
Chromium	Ave.	0.10	0.000010
	Max.	0.30	0.000031
Lead	Ave.	0.10	0.000010
	Max.	0.30	0.000031
Zinc	Ave.	0.10	0.000010
	Max.	0.30	0.000031


RECYCLE 98%
COOLING TOWER
VACUUM DEGASSING OPERATION
CLASSIFIER (SCALE PIT)
SOLIDS
FILTER
TO POTW
REFER TO TABLE XIII-I FOR THE EFFLUENT QUALITY AND LOADS.

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
VACUUM DEGASSING
PRETREATMENT MODEL

Dwn.9/10/79

FIGURE XIII-1

CONTINUOUS CASTING SUBCATEGORY

SECTION I

PREFACE

The USEPA is proposing effluent limitations guidelines and standards for the steel industry. The proposed regulation contains effluent limitations guidelines for best practicable control technology currently available (BPT), best conventional pollutant control technology (BCT), and best available technology economically achievable (BAT) as well as pretreatment standards for existing and new sources (PSES and PSNS) and new source performance standards (NSPS), pursuant to Sections 301, 304, 306, 307 and 501 of the Clean Water Act.

This part of the Development Document highlights the technical aspects of EPA's study of the Continuous Casting Subcategory of the Iron and Steel Industry. Volume I of the Development Document discusses issues pertaining to the industry in general, while other volumes relate to the remaining subcategories of the industry.

CONTINUOUS CASTING SUBCATEGORY

SECTION II

CONCLUSIONS

This report highlights the technical aspects of EPA's study of the Continuous Casting Subcategory of the Iron and Steel Manufacturing Category.

Based on this current study and a review of previous studies, the Agency has reached the following conclusions.

1. The Agency has again decided not to further subdivide the continuous casting subcategory. It found no significant differences in applied or discharge flow rates between slab, bloom, and billet continuous casters. Wastewater quality and flow rates were not found to differ significantly between carbon and specialty steel continuous casting operations.

2. The previously promulgated BPT limitations for continuous casting operations are practicable and achievable. In fact, the expanded data base shows the previous BPT limitations are more lenient than can now be justified. Nonetheless, the proposed BPT limitations are identical to the limitations previously promulgated.

3. Sampling and analysis of continuous casting wastewaters revealed the presence of five toxic metal pollutants (chromium, copper, lead, selenium, and zinc). Discharge of these toxic pollutants can be reduced by several available economically achievable wastewater treatment technologies. A summary of the pollutant discharges from the continuous casting subcategory at the proposed BPT, BAT, and BCT levels of treatment, are shown below.

	Effluent Discharges (Tons/Year)		
	Raw Waste	Proposed BPT	Proposed BAT and BCT
Flow (MGD)	238	8.8	1.8
TSS	21,735	666	40
Oil & Grease	9,060	200	13
Toxic Metals	590	22	1.3

4. EPA estimates that industry will incur the following costs to comply with the proposed continuous casting limitations and standards.

	Costs (Millions of 7/1/78 Dollars)			
		Investment		Total
	Total	In-place	Required	Annual
BPT	102.6	60.7	41.9	23.9
BAT	4.35	-	4.35	0.78
TOTAL	106.95	60.7	46.25	24.68

NOTE: The PSES costs are included in the costs for BPT and BAT.

5. The Agency evaluated the "cost/reasonableness" of controlling the conventional pollutants, TSS and oil and grease, and concluded that the control cost based upon the BCT model treatment system, (which is identical to the BAT-1 model treatment system), is less than the cost experienced by publicly owned treatment works (POTWs). Therefore, EPA is proposing BCT limitations for the continuous casting subcategory based upon the BCT model treatment system.

6. BAT, NSPS, PSES, and PSNS limitations and standards are being proposed for zinc. For the purpose of facilitating central treatment of compatible wastewaters, the Agency is proposing BAT, NSPS, PSES, and PSNS limitations and standards for chromium and lead as well.

7. The proposed NSPS for the continuous casting subcategory are equal to the proposed BCT limitations for conventional pollutants and the proposed BAT limitations for toxic pollutants.

8. EPA has proposed pretreatment standards for new and existing sources (PSNS and PSES) which are identical to the proposed BAT limitations for toxic metals. These standards are intended to minimize the impact of continuous casting wastewater pollutants which would interfere with, pass through, or otherwise be incompatible with POTW operations.

9. With regard to the "remand issues," the Agency has concluded that:

   a. Neither relaxed effluent limitations nor retrofit cost allowances are appropriate for older continuous casting plants. Analysis indicates that the age of a continuous caster has no significant effect upon the ease or cost of retrofitting pollution control equipment.

   b. The effects of the consumptive use of water resulting from attainment of the proposed effluent limitations will be minimal on both an industry-wide and on an arid or semi-arid regional basis. The model treatment systems include cooling towers and recycle systems. The Agency has determined that to retrofit all continuous casting plants with cooling towers would only result in a consumptive usage of 1.7% of the 238 MGD of water presently applied to continuous casters.

10. The Agency found that about twenty-five percent of the continuous casting operations achieve zero discharge. The Agency is soliciting comments on whether zero discharge limitations should be promulgated at the BAT, BCT, NSPS, PSES, and PSNS levels based upon the demonstrated performance of plants in this subcategory. These plants are currently achieving zero discharge with BPT model treatment system components. Hence, no additional costs beyond those required for BPT would be necessary to achieve zero discharge.

11. Table II-1 presents the treatment model flow and effluent quality data used to develop the proposed BPT effluent limitations for the continuous casting subcategory, and Table II-2 presents these proposed limitations. Table II-3 presents the treatment model flow and effluent quality data used to develop the proposed BAT and BCT effluent limitations and the proposed NSPS, PSES, and PSNS for the continuous casting subcategory. Table II-4 presents these proposed limitations and standards.

TABLE II-1

BPT TREATMENT MODEL FLOWS AND EFFLUENT QUALITY CONTINUOUS CASTING SUBCATEGORY

Pollutant	Monthly Average[(1)] Concentration (mg/l)
Flow, gal/ton	125
TSS	50
O&G	15
pH, Units	6.0 to 9.0

---

(1): Daily maximum concentrations are three times the above monthly average concentrations.

TABLE II-2

PROPOSED BPT EFFLUENT LIMITATIONS CONTINUOUS CASTING SUBCATEGORY

Pollutant	Effluent Limitations(1) (kg/kkg of Product)
TSS	0.026
O&G	0.0078
pH, Units	Within the range 6.0 to 9.0

---

(1): Daily maximum effluent limitations are three times the above monthly average effluent limitations.

TABLE II-3

TREATMENT MODEL FLOWS AND EFFLUENT QUALITY CONTINUOUS CASTING SUBCATEGORY

		Monthly Average Concentration$^{(1)}$ (mg/1)				
	Pollutant	BAT	BCT	NSPS	PSES	PSNS
	Flow, gal/ton	25	25	25	25	25
	TSS	-	15	15	-	-
	O&G	-	10*	10*	-	-
119	Chromium	0.10	-	0.10	0.10	0.10
122	Lead	0.10	-	0.10	0.10	0.10
128	Zinc	0.10	-	0.10	0.10	0.10
	pH, Units	-	6.0 to 9.0	6.0 to 9.0	-	-

---

* : As shown, daily maximum concentration only.

(1): Daily maximum concentrations are the above monthly average concentrations multiplied by the following factors:

Pollutant	Factor
TSS	2.67
Chromium, Lead, Zinc	3.0

TABLE II-4

PROPOSED EFFLUENT LIMITATIONS AND STANDARDS CONTINUOUS CASTING SUBCATEGORY

		Effluent Limitations and Standards[(1)] (kg/kkg of Product)				
	Pollutant	BAT	BCT	NSPS	PSES	PSNS
	TSS	-	156	156	-	-
	O&G	-	104*	104*	-	-
119	Chromium	1.04	-	1.04	1.04	1.04
122	Lead	1.04	-	1.04	1.04	1.04
128	Zinc	1.04	-	1.04	1.04	1.04
	pH, Units	-	6.0 to 9.0	6.0 to 9.0	-	-

---

* : As shown, daily maximum limitation or standard.

(1): The proposed limitations and standards have been multiplied by 10^5 to obtain the values presented in this table.
Daily maximum effluent limitations and standards are the above monthly average limitations and standards multiplied by the following factors:

Pollutant	Factor
TSS	2.67
Chromium, Lead, Zinc	3.0

CONTINUOUS CASTING SUBCATEGORY

SECTION III

INTRODUCTION

General Discussion

Steel producers have recognized for many years that continuous casting methods are more efficient than traditional methods to convert the molten steel into semi-finished products. The first U.S. patent for continuous casting was issued to Sir Henry Bessemer in 1865, but the mechanical and material problems associated with the development of equipment prevented the successful introduction of continuous casting to the steelmaking industry. In 1943, Junghans started work which ultimately resulted in the successful continuous casting of steel. This work was followed by that of the Babcock and Wilcox Company in the United States in 1946; Gebr. Boehler, A. G. of Austria in 1947; Allegheny Ludlum Steel Company in the United States in 1949; and the Mannesmann Group of Germany in 1950. Since then, the continuous casting of steel has increased, and today considerable effort has been made to improve equipment and techniques.

The continuous casting process takes molten steel produced in the basic oxygen or electric arc furnace steelmaking processes and continuously casts the molten steel through a water cooled copper mold to produce a semi-finished product. Figure III-1 illustrates the process sequence for the manufacture of steel.

During the continuous casting process, as the semi-solidified (liquid center) steel emerges from the molds, water is sprayed onto the semi-finished product to further cool and solidify the cast product. This results in the creation of process wastewaters which require treatment prior to discharge. This report reviews the treatment alternatives for continuous casting wastewaters and presents proposed effluent limitations and standards.

Data Collection Activities

The Agency sampled seven continuous casting operations for this study to acquire process information and wastewater quality data. The previous regulation promulgated in 1974 was primarily based upon data obtained through field sampling at four continuous casting plants. Four additional plants were sampled during the recent plant survey. One plant, Plant AE, was resampled as Plant 075 during this survey. The casting plants that were sampled are listed in Table III-1.

In 1976, Data Collection Portfolios (DCPs) were sent to all fifty continuous casting operations in the United States. Each provided information regarding applied and discharge flow rates, treatment systems installed, shop capacities, and modes of operation. Table III-2 presents an inventory of continuous casting shops based upon the

DCP responses. In addition, plant visit data have been tabulated and summarized.

After the Agency received and reviewed the DCP responses, it sent detailed Data Collection Portfolios (D-DCPs) to nine casting shops to gather information on long term effluent quality, treatment costs, and on the continuous casting process itself. Table III-3 summarizes the data base for this report as derived from the above mentioned sources of information.

The originally promulgated limitations for continuous casting operations did not contain any subdivision. An examination of the additional data received since the original promulgation indicates that the Agency's original decision not to further subdivide the casting subcategory into slab, bloom, and billet, or carbon and specialty subdivisions was appropriate. Accordingly, the proposed limitations do not contain any further subdivisions. The discussion and the data presented throughout this report reflect the above subcategorization.

Description of Continuous Casting Operations

An integral part of the steelmaking process is the conversion of molten steel into a semi-finished product or shape that is suitable for further processing. Conventional practice is to: (1) teem (pour) the molten steel into iron ingot molds; (2) cool the ingots (3) strip the ingots out of the molds; (4) transfer the ingots to soaking pits for heat equalization; (5) heat the ingots to rolling temperatures; (6) and finally, roll the ingots into blooms, billets, or slabs. Continuous casting, on the other hand, is a process in which the molten steel is converted directly to blooms, billets, or slabs, eliminating the above steps, increasing productivity, and conserving energy.

In the continuous casting process, the hot molten steel is poured from the ladle into a refractory lined tundish. The tundish serves to maintain a constant head of molten metal. This is essential in providing a controlled casting rate. In addition, the tundish can distribute the molten steel to more than one casting strand in multiple strand operations (see Figure III-2). The molten metal from the tundish pours through nozzles into an oscillating water cooled copper mold, where partial solidification takes place. The copper molds oscillate to prevent the molten steel from sticking to the sides of the molds. Lubricants, such as rape seed oil, are sprayed into the molds to facilitate steel movement through the mold. As the metal solidifies in the mold, the cast product is withdrawn continuously. After passing through the water cooled molds, the partially solidified product passes into a secondary cooling zone, where sprays of water remove sufficient heat to complete solidification of the semi-finished product. The semi-finished product then passes into the cut-off zone, where the product is cut to the desired length. It is then placed on the run-out conveyor tables for transport to storage facilities.

The rate of casting product withdrawal is determined by the type of steel cast (i.e. alloy, carbon), and by the size and geometry of the section. Generally, bloom and billet continuous casters are multiple strand machines, whereas large slab casters are single strand, although double strands are also used. A withdrawal rate (casting speed) that is too rapid will cause molten steel breakouts in bloom and billet casting machines and will cause corner cracking in slab casting machines. Casting times, for a ladle of molten steel, are generally about 60 minutes. Longer casting times cause the molten steel to lose too much heat, resulting in poor casting.

The casting machines also require a turn around time for routine maintenance. It normally takes 60 minutes to prepare machines (strands) for the next cast.

Generally, three types of designs are used for continuous casting machines, i.e., vertical casting, vertical casting with bending rolls, and curved mold. These three designs are described as follows.

1. The vertical casting design was the first type of continuous caster used. In these casters the semi-finished product is maintained in a vertical position until after it has been cut to product length. Then the cut length is lowered into a tilting basket which rotates and discharges the product onto the run-out and cooling tables. Vertical casting machines require relatively tall building structures.

2. The vertical casting with bending roll design casts the product vertically. However, after solidification, the semi-finished product is curved horizontally by bending rolls with a horizontal straightening mechanism. This design allows for decreased mill building heights.

3. The curved mold design employs a curved water cooled mold and curved cooling chamber, which automatically withdraws a curved semi-finished product and discharges the product horizontally. A straightening mechanism is also used on the semi-finished product. This design has the smallest building height requirements.

Bloom, billet, and slab casting machines are designed to cast mixed semi-finished product sizes. By this method, product size can be matched to the requirements of the subsequent rolling operations. The mold sizes are changed between casts. For example, casting dimensions for a six strand billet caster are 4" to 7" square sections, whereas for the bloom machine they are from 6" to 12 1/2" square, and 12' to 40' in length. Stainless, low alloy, and other steel material specifications can be continuously cast. Withdrawal rates, cooling rates, and metal temperature are the governing factors for the casting machines.

Description of Pressure Casting

Pressure casting or pressure pouring is another method of casting semi-finished products from molten steel, but it is generally used for stainless steel or low-alloy steel slab production. Pressure casting is also of interest to carbon steel producers, because improved yield and surface finishes can be obtained with this process. However, other operational problems have made pressure casting less competitive. Pressure casting was originally developed for the production of steel wheels for railroad cars, but soon was adapted to the production of other semi-finished products.

The principal equipment used in pressure casting is:

1. Pressure tank
2. Ladle
3. Mold
4. Handling mechanism
5. Air compressor station

Molds are usually made by assembling rectangular blocks of graphite to form a cavity of the desired dimensions. The pressure casting operation involves placing the ladle of molten steel into a pressure chamber. The pressure chamber is then sealed with a special cover that is mounted with a ceramic pouring tube. The mold is moved into position, and a seal is made between the mold and pressure tank cover pouring tube. Pressurized air is introduced into the pressure chamber forcing the molten metal up into the cavity in the graphite molds. The pouring tube is then sealed with a plug and the pressure released from the chamber. The filled graphite mold is removed from the pressure chamber. The slab or bloom is held in the mold for sufficient time to complete solidification, after which the mold is opened, and the cast product is removed.

The size of the heat to be handled in a pressure casting shop is an important consideration, because a sufficient number of molds must be available to handle the entire heat within a reasonable pouring time (approximately one hour). The cost of molds generally accounts for about one half of the capital equipment cost.

The continuous casting and pressure casting processes are illustrated in Figures III-2 through III-4.

Although both processes cast molten steel to produce semi-finished products, pressure and continuous casting operations employ different procedures and technologies to perform the casting operation. In view of this, the Agency believes that the pressure casting process may differ significantly from the continuous casting process. The Agency does not have sufficient data relating to pressure casters to propose limitations and standards for those operations. Moreover, since there are only a few pressure casting operations, the Agency believes that limitations for those operations should be established on a case-by-case basis. For this reason, the Agency is not proposing limitations for pressure casting operations at this time.

TABLE III-1

SUMMARY OF SAMPLED PLANTS
CONTINUOUS CASTING SUBCATEGORY

Sample Code	Plant Reference Code	Type of Caster	Steel Type
*AE	0584F	Slab	Carbon
AF	0868B	Slab	Carbon
D	0248B	Slab	Specialty
Q	0684D	-	Specialty
071	0284A	Slab	Specialty
072	0496	Slab	Carbon
*075	0584F	Slab	Carbon
079	0060K	Billet	Carbon

-: Inadequate response to the basic DCP.

*: This plant was sampled twice; once during the Original Guidelines Survey as Plant AE and once during the Toxic Pollutant Survey as Plant 075. The data gathered during the toxic survey is considered to be the most representative of plant operations and, therefore, is used instead of the original survey data.

TABLE III-2

GENERAL SUMMARY TABLE
CONTINUOUS CASTING

						Prod. Ton/Day		Flows Gal/Ton					
Plant Code	Casting Process	Type of Steel	Products Cast	# of Strands Per Machine	Plant Age	Rated Capacity	1976 Prod.	Applied Flow	Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0060	Cont.& Cont.-Cont.	CS-98 HSLA-2	Slabs	2	1972	3800	1812	-	-	PSP	FLL FLO2,CL VF,CT	RTP 100	Zero Discharge
0060D	Cont.	ES-78, SS-22	Slabs	2	1970	1000	789	1678	554	None	FDS,PSP CL,CT,VF	RTP 67 BD 33	Direct
0060H	Cont.	CS-100	Billets	6	1964	1200	975	923	92	PSP,SSP, Scr, CT	None	RTP 90 BD 10	Indirect(1)
0060K	Cont. & Cont.-Cont.	CS-100	Billets	4	1968 1975	655	327	[2985]	[25]	PSP FF,CT	None	[RTP 99.2] [BD 0.8]	Direct
0068B	Cont.	CS-100	Billets	-	1975	880	360	6111	611	PSP	None	RUP 90 REU 10	Zero Discharge
0076	Cont.	CS-100	Billets	3	1975	700	255(2)	1656	0	PSP	T,VF	RTP 100	Zero Discharge
0084A	Cont. & Cont.-Cont.	CS-100	Billets	3	1975	450	300(3)	-	-	PSP,SS	SSP,Scr, CT	RUP 100	Zero Discharge
0084A	Cont. & Cont.-Cont.	CS-100	Billets	2	1970	300	65(3)	-	-				
0112D	Cont.	CS-95, HSLA-5	Slabs	2	1976	4100	2840	6408	128	01,02,03	NA,01,02, NL,NW,FLP, CL,SS,T,SL VF	RTP 98 BD 2	Direct
0132	Cont.	CS-80, AS-20	-	3	1970	540	467	-	-	None	None	-	-

TABLE III-2
GENERAL SUMMARY TABLE
CONTINUOUS CASTING
PAGE 2

Plant Code	Casting Process	Type of Steel	Products Cast	# of Strands Per Machine	Plant Age	Prod. Ton/Day		Flows Gal/Ton		Process Treatment	Central Treatment	Operating Mode	Discharge Mode
						Rated Capacity	1976 Prod.	Applied Flow	Discharge Flow				
0136B	Cont.	CS-96 HSLA-4	-	-	1967	576	501	-	-	None	None	-	-
0180	Cont. & Cont.-Cont.	CS-100	Billets	2	1970	400	329	4012	4.0	None	PSP,SL,SS	RTP 99.9 BD 0.1	POTW
0188C	Cont.-Cont.	CS-100	-	-	1976	1200	210	-	-	None	None	-	-
0196A	Cont. & Cont.-Cont.	-	Billets	6	1976	*	*	*	*	PSP,SS CT	None	RTP 89 BD 11	Direct
0204	Cont.	CS-100	Billets	4	1975	1000	853	2543	2543	None	None	REU 100	Indirect
0248B	Cont.	SS-99.9, other 0.1	Slabs	1	1972	1100	500	2000	0	PSP,SSP, SS,FDSP, Scr,CL	None	RTP 100	Zero Discharge
0284A	Cont.	SS-100	Slabs	1	1974	550	296	[564]	[0]	PSP, FSP,T,CT	None	[RTP 100]	Zero Discharge
(4)0316	Cont.	CS-100	-	2	1965	850	533	-	-	None	None	-	-
0316A	Cont. & Cont.-Cont.	CS-100	Billets	3	1970	900	383	-	-	None	None	-	-
0384A	Cont-Cont.	CS-64.8, HSLA-35.2	Billets and Blooms	4	1970	1370	1668	3281	16	PSP,SS, FDSP,CT	None	RTP 97.1(5) BD 0.5	Direct
0384A	Cont-Cont.	CS-100	Slabs	2	1972	4110	4422	7062	98	PSP,SS, FDSP,CT,CL	None	RTP 97 BD 1.4	Direct

TABLE III-2
GENERAL SUMMARY TABLE
CONTINUOUS CASTING
PAGE 3

Plant Code	Casting Process	Type of Steel	Products Cast	# of Strands Per Machine	Plant Age	Prod. Ton/Day Rated Capacity	Prod. Ton/Day 1976 Prod.	Flows Gal/Ton Applied Flow	Flows Gal/Ton Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0432A	Cont.	CS-100	Billets	6	1969	1500	1000	2496	56	PSP,SSP, VF,SS	None	RTP 97.8 BD 2.2	Direct
0444	Cont.	CS-99, Other-1	Billets	3	1974	500	326	4294	245	PSP,FDSP CL	None	RTP 94.3 BD 5.7	POTW
0456A	Cont.	CS-100	-	-	1970	600	192	-	-	None	None	-	-
0460A	Cont.	CS-100	Billets	6	1968	950	479	4509	1527	PSP,CT	None	RTP 66.2 RET 33.8	Indirect Discharge
(6)0468B	Cont. & Cont.-Cont.	CS-95, Other-5	Billets	4	1969 1970	1600	1403	927	128	PSP	SSP,CT, FDSP,SS	RTP 86 BD 14	Direct
(6)0468F	Cont. & Cont.-Cont.	CS-100	Billets	4	1976	3450	801	2187	28	PSP	SL,SS,CT	RTP 98.7 BD 1.3	Direct
0476A	Cont. & Cont.-Cont.	CS-100	Blooms	6	1969	-	533	16,210	81	SL	FLP,Scr, SS,ML, CL,04	RTP 99.5 BD 0.5	Direct
0496	Cont.	CS-90, HSLA-10	Slabs	1	1971	1600	940	[1542]	[0]	None	PSP,FLP, FDSP,CLA, CT	[RTP 100]	Zero Discharge
0528A	Cont.-Cont.	CS-93, HSLA-7	Slabs	4	1968	6575	5609	4814	144	PSP,SSP, CT,FDSP	CL,FLP,SL, PSP,SSP,T, SS,ML,NA, KB,CO,Scr,	RTP 97 BD 3	Direct

TABLE III-2
GENERAL SUMMARY TABLE
CONTINUOUS CASTING
PAGE 4

Plant Code	Casting Process	Type of Steel	Products Cast	# of Strands Per Machine	Plant Age	Prod. Ton/Day Rated Capacity	Prod. Ton/Day 1976 Prod.	Flows Gal/Ton Applied Flow	Flows Gal/Ton Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0548D	Cont.	CS-86, AS-14	Rounds	2	1974	600	253	3755	79	None	PSP,SS	RTP 97.9 BD 2.1	Direct
0584F	Cont.	CS-100	Slabs	4	1968	4118	3567	[3489]	[117]	PSP,FFP, CT	05,06, SL	[RTP 97] [BD 3]	Direct
0596	Cont.	CS-100	Billets	5	1973	800	434	5161	0	None	CT,FDSP SL	RTP 100	Zero Discharge
0608A	Cont.	CS-100	Billets	3	1976	600	500	2764	11	None	PSP,SSP Spray Cooling Pond	RTP 99.6 BD 0.4	Direct
0620A	Cont-Cont.	CS-99, AT-1	Billets	2	1969	900	864	22	0	None	SL,PSP, FDSP	RTP 100	Zero Discharge
0620B	Cont. & Cont.-Cont.	CS-100	Billets	2	1973	800	900	2000	24	None	PSP,SS, SSP,SL, CT,Scr 05,CLA,FLP	RTP 98.9 BD 1.1	Direct
0620C	Cont. & Cont.-Cont.	CS-90, HSLA-10	-	2	1975	1200	800	-	-	None	None	-	-
0652	Cont.	CS-90, HSLA-10	Slabs	2	1968	1440	851	1375	1375	None	PSP,Scr,SS, SL,FLA,FLP, NL,CLA	OT	Direct
(6)0672A	Cont. & Cont.-Cont.	CS-100	Billets	2	1963	1152	622	547	0	PSP,SSP, NC,CT,Scr	None	RTP 100	Zero Discharge
0672B	Cont. & Cont.-Cont.	CS-100	-	-	1975	700	252	-	-	None	None	-	-

TABLE III-2
GENERAL SUMMARY TABLE
CONTINUOUS CASTING
PAGE 5

Plant Code	Casting Process	Type of Steel	Products Cast	# of Strands Per Machine	Plant Age	Prod. Ton/Day Rated Capacity	Prod. Ton/Day 1976 Prod.	Flows Gal/Ton Applied Flow	Flows Gal/Ton Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0684E	Cont.	AS-84.6, CS-15.4	Billets	4	1969	1134	693	1375	49(9)	PSP,CT	FLL,FLP, FLO1,CL,CT	RTP 96.5 BD 3.5	Direct
0684E	Cont.	SS-100	Slabs	-	1969	670	107						
(6)0696A	Cont.	CS-58, other-42	Billets	2	1964 1975	960	293	1341	66	PSP,CT	None	RTP 95.1 BD 4.9	POTW
0740A	Cont.	CS-100	Billets	2	1964	380	378	1415	1.2	None	Settling Pond,CT	RTP 99.9 BD 0.1	POTW
0764	Cont.	CS-100	-	-	1976	720	294	-	-	None	None	-	-
0780	Cont.	CS-100	Billets	2	1966	500	348	1934(9)	0	MA,PSP, CT	None	RTP 100	Zero Discharge
0780	Cont. & Cont.-Cont.	CS-100	Billets	3	1975	700	350						
0796A	Cont.	HSLA- 94.8, CS-5.2	Blooms	4	1968	900	354	-	-	None	None	-	-
(7)0856F	Cont.	CS-100	Blooms	2	1973	1500	900(8)	1278(9)	1278(9)	PSP,SSP, SS	None	OT	Direct
0860B	Cont.-Cont.	CS-100	Slabs	1	1967	4156	4008	5489	5489	PSP,SS	None	OT	Direct
0860H	Cont.-Cont.	CS-96.4 HSLA, AT,ES-3.6	Billets	4	1971	2542	1605	5318	5318	PSP, SS,SSP	Scr,CL, FLA,FLP, VF,CT	RET 100	Zero Discharge

TABLE III-2
GENERAL SUMMARY TABLE
CONTINUOUS CASTING
PAGE 6

Plant Code	Casting Process	Type of Steel	Products Cast	# of Strands Per Machine	Plant Age	Prod. Ton/Day Rated Capacity	Prod. Ton/Day 1976 Prod.	Flows Gal/Ton Applied Flow	Flows Gal/Ton Discharge Flow	Process Treatment	Central Treatment	Operating Mode	Discharge Mode
0864C	Cont.	CS-70, AT-25, HSLA-5	Billets, Blooms	4	1968	820	368	-	571	PSP	SSP, SL, FLP, SS, CT	-	Direct
0868B	Cont.	CS-78.5, HSLA-21.5	Slabs	1	1971	1435	1395	8258	310	PSP, SS, FDSP, CT	-	RTP 96.2 BD 3.8	Direct
0946A	Cont.	CS-87, HSLA-13		8	1966	870	234(10)	-	-	None	None	-	-

TABLE III-2
GENERAL SUMMARY TABLE
CONTINUOUS CASTING
PAGE 7

(1) Percolation and evaporation.

(2) Production is for 1975 as there was no production in 1976.

(3) The DCP reported only total tonnage for the two casters. However, a split could be made based upon typical production which was reported separately for each caster.

(4) Data refers to two identical casters. Production reported is combined tonnage for the two casters.

(5) DCP reports 2.4% evaporation.

(6) Two machines located at this plant. Flow and tonnage data is combined for the two casters.

(7) Two identical machines.

(8) Typical production. Separate 1976 tonnage not available.

(9) Combined GPT for both machines.

(10) No production in 1976. Tonnage is for 1975.

- Inadequate response.
* Confidential information

NOTE: All data was derived from the basic questionnaire responses with the exception of bracketed data.
Data in brackets was derived from the plant sampling visit data.

KEY TO ABBREVIATIONS

The general abbreviation key is found in Table VII-1.
The abbreviations defined on this page apply to this summary table.

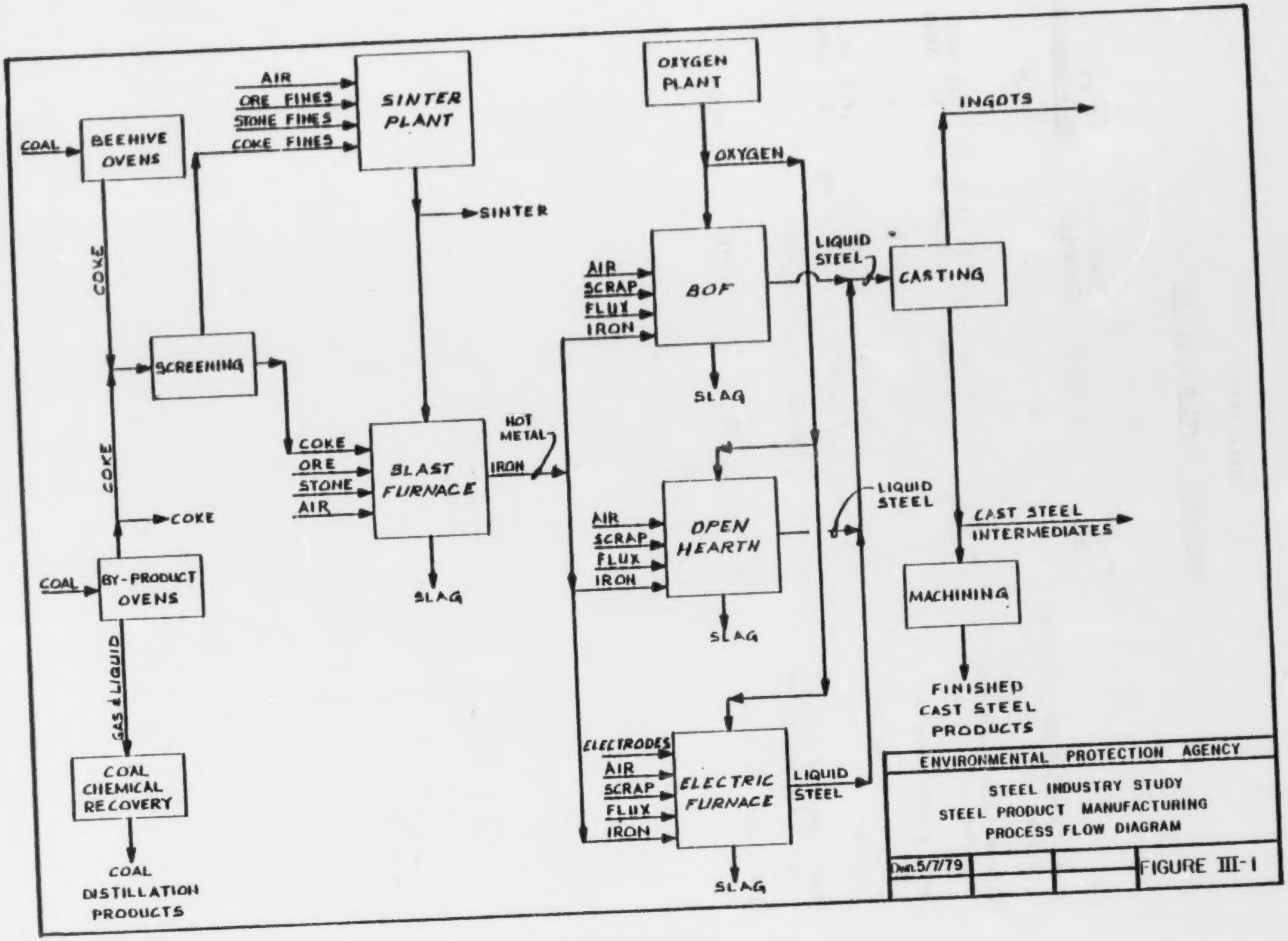
AS# : % alloy steel
AT# : % alloy tool
CS# : % carbon steel
ES# : % electrical steel
HSLA#: % high strength low alloy
SS# : % stainless steel

FLO1: flocculation with ferric chloride
FLO2: flocculation with ferric sulfate
01 : pH control
02 : biocide
03 : corrosion inhibitors
04 : mechanical aeration
05 : hydromation filters
06 : deep bed filters with walnut shells

TABLE III-3

CONTINUOUS CASTING DATA BASE

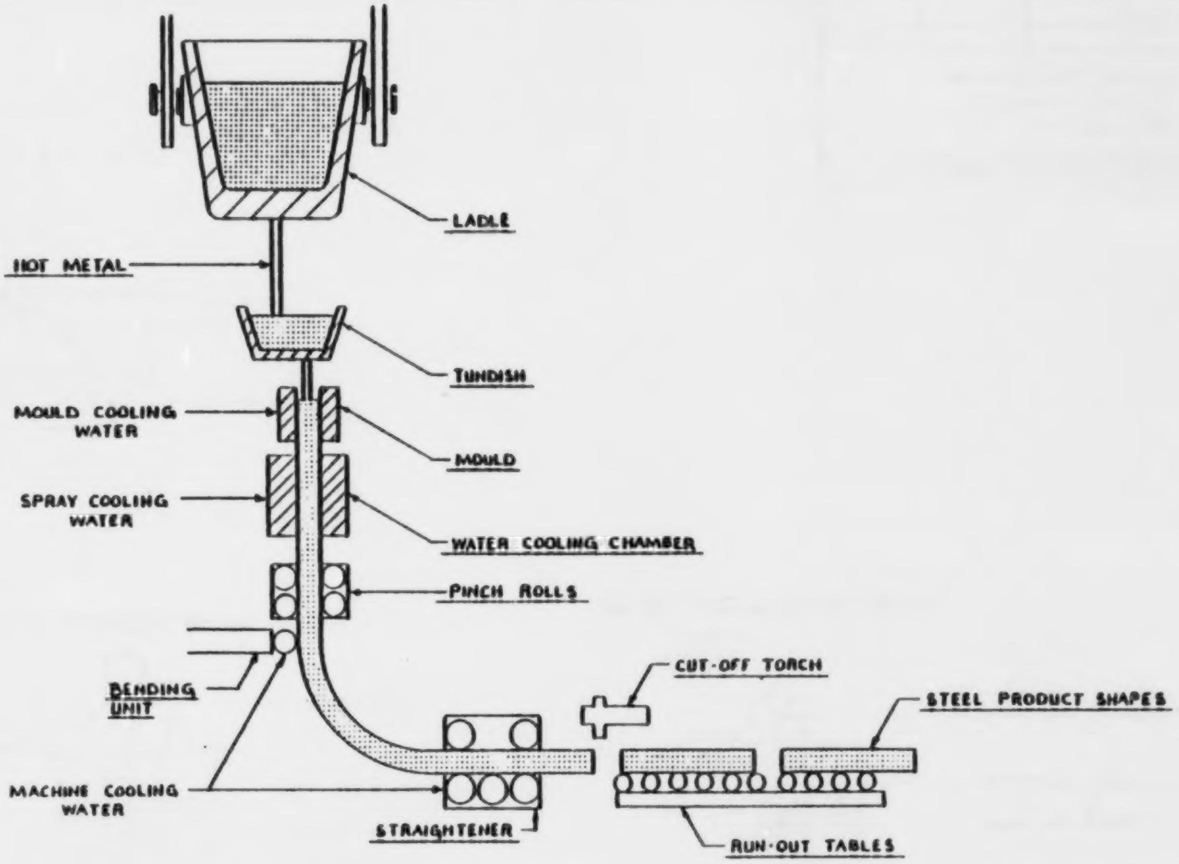
	No. of Plants	% of Total	Daily Capacity	% of Daily Capacity
Plants sampled for original survey	4	8.0	7214	9.9
Plants sampled for toxic survey	4 incl. 1 above	8.0 incl 2.0 above	6923 incl. 4118 above	9.5 incl. 5.7 above
Total plants sampled	7	14.0	10,019	13.8
Plants solicited via D-DCP	9 incl. 2 above	18.0 incl. 4.0 above	20,309 incl. 1,650 above	27.9 incl. 2.3 above
Plants sampled and/or solicited via D-DCP	14	28.0	28,678	39.5
Plants responding to DCP	50	100.0	72,691	100.0


COAL
BEEHIVE OVENS
COKE
SCREENING
COKE
COAL
BY-PRODUCT OVENS
COKE
GAS & LIQUID
COAL CHEMICAL RECOVERY
COAL DISTILLATION PRODUCTS
AIR
ORE FINES
STONE FINES
COKE FINES
SINTER PLANT
SINTER
COKE
ORE
STONE
AIR
BLAST FURNACE
SLAG
HOT METAL
IRON
OXYGEN PLANT
OXYGEN
AIR
SCRAP
FLUX
IRON
BOF
SLAG
AIR
SCRAP
FLUX
IRON
OPEN HEARTH
SLAG
ELECTRODES
AIR
SCRAP
FLUX
IRON
ELECTRIC FURNACE
SLAG
LIQUID STEEL
LIQUID STEEL
LIQUID STEEL
CASTING
INGOTS
CAST STEEL INTERMEDIATES
MACHINING
FINISHED CAST STEEL PRODUCTS
Dwn.5/7/79

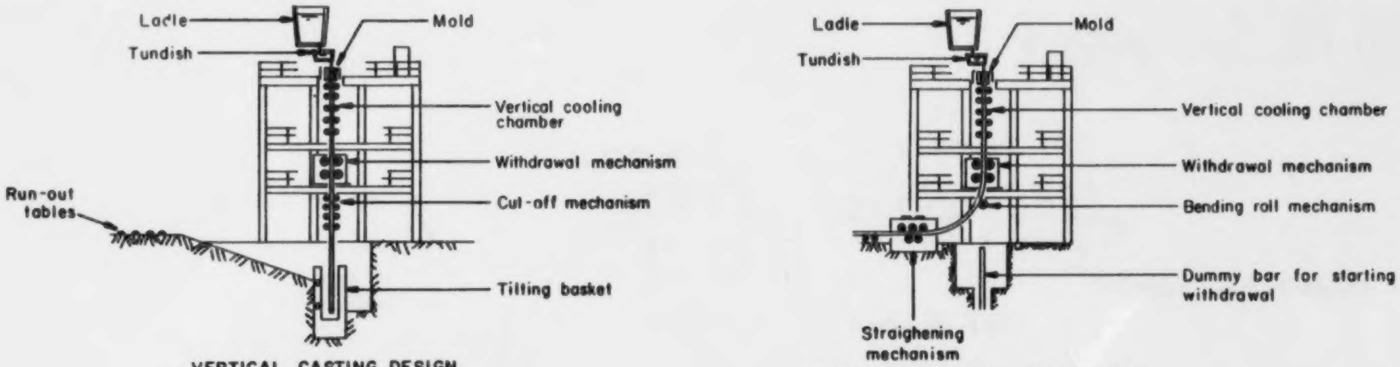
ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
STEEL PRODUCT MANUFACTURING
PROCESS FLOW DIAGRAM

FIGURE III-1

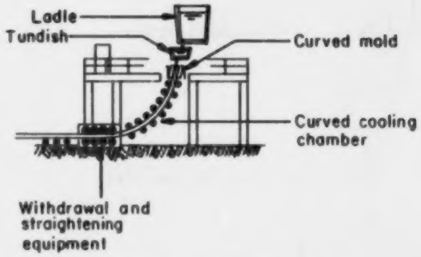

LADLE
HOT METAL
TUNDISH
MOULD COOLING WATER
MOULD
SPRAY COOLING WATER
WATER COOLING CHAMBER
PINCH ROLLS
BENDING UNIT
CUT-OFF TORCH
STEEL PRODUCT SHAPES
MACHINE COOLING WATER
STRAIGHTENER
RUN-OUT TABLES

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
CONTINUOUS CASTING
PROCESS FLOW DIAGRAM
RD 4/24/78
FIGURE III-2


Ladle
Tundish
Mold
Vertical cooling chamber
Withdrawal mechanism
Cut-off mechanism
Run-out tables
Tilting basket
Ladle
Tundish
Mold
Vertical cooling chamber
Withdrawal mechanism
Bending roll mechanism
Dummy bar for starting withdrawal
Straighening mechanism

VERTICAL CASTING DESIGN

VERTICAL & BENDING ROLL DESIGN


Ladle
Tundish
Curved mold
Curved cooling chamber
Withdrawal and straightening equipment

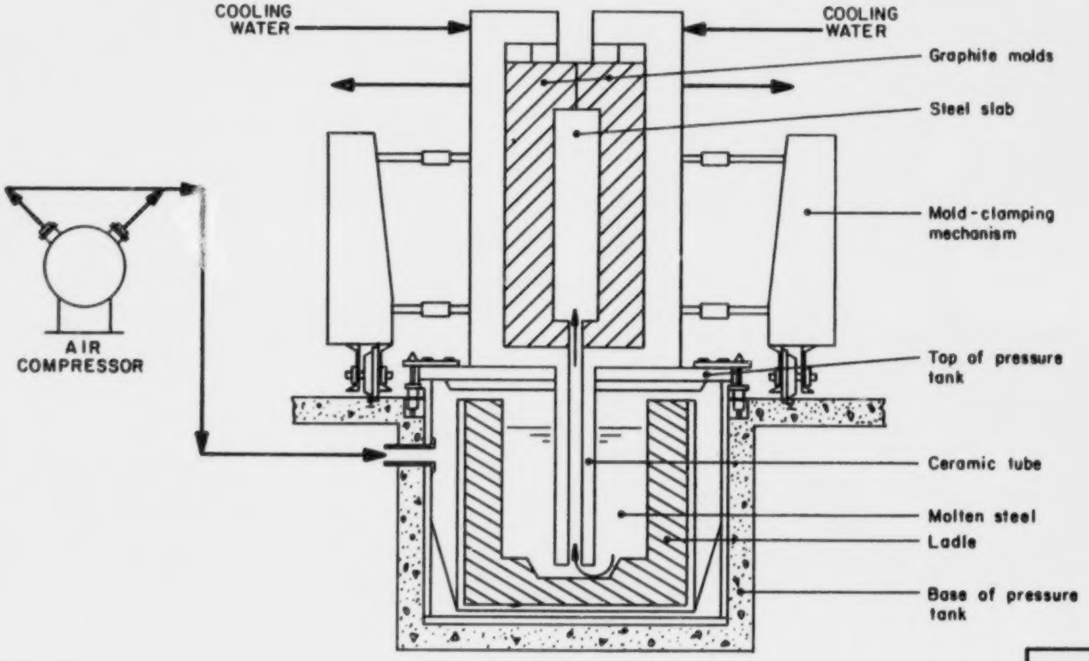
CURVED MOLD DESIGN

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
CONTINUOUS CASTING
PROCESS FLOW DIAGRAM

Dwn. 2/23/79

FIGURE III-3


COOLING WATER
COOLING WATER
Graphite molds
Steel slab
Mold-clamping mechanism
AIR COMPRESSOR
Top of pressure tank
Ceramic tube
Molten steel
Ladle
Base of pressure tank

PRESSURE CASTING OF A SLAB

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
PRESSURE CASTING
PROCESS FLOW DIAGRAM
Dwn. 2/23/79
FIGURE III-4

CONTINUOUS CASTING SUBCATEGORY

SECTION IV

SUBCATEGORIZATION

Introduction

The Agency examined several factors to determine if the continuous casting subcategory should be subdivided. Those factors include manufacturing processes and equipment, final products, raw materials, wastewater characteristics, wastewater treatability, size and age of facilities, geographic location, and process water usage and discharge rates. All were found to have no significant effect upon subcategorization. The following discussion addresses each of these factors and confirms the proposed continuous casting subcategorization.

Factors Considered in Subdivision

Manufacturing Process and Equipment

The continuous casting operation is a process in which molten steel is cast into a semi-finished product. Its particular process characteristics distinguish it from other steelmaking operations. However, the Agency concluded that further subdivision of the continuous casting subcategory was not warranted. The process and equipment required is basically the same for all continuously cast products.

Differences among casters are found in the casting control parameters such as temperature, tundish nozzle pouring rates, withdrawal rates, cooling rates, and type of caster design. These parameters, however, do not significantly affect wastewater quantity or quality.

Final Products

Continuous casting operations produce a wide variety of semi-finished products, varying in material composition and geometric form. The basic process, though, of transforming molten steel to a semi-finished product is the same. Sampling data do not indicate any significant differences between carbon steel casters and specialty steel casters nor among billet, bloom, or slab casters. Consequently, the Agency concluded that a further subdivision based upon the final product of continuous casting operations is not appropriate.

Raw Materials

The Agency found that raw materials do not differentiate continuous casting facilities. The sampling data for specialty and carbon steel casters exhibit no appreciable differences in the type and nature of wastewaters produced. Sampling data are presented in Section VII.

Wastewater Characteristics

Although continuous caster wastewaters are distinguishable from those of the other steel industry subcategories, a review of sampling data indicates no discernible pattern or apparent division among casters, regardless of caster type or the type of steel cast. The Agency, therefore, concludes that there is no justification for further subdivision on the basis of wastewater characteristics.

Wastewater Treatability

Continuous casting wastewater treatment does not vary appreciably from plant to plant. While the Agency observed differences in the concentrations of wastewater constituents, it also noted a common approach to wastewater treatment. The major treatment components used in these operations are gravity sedimentation devices, filters, and recycle systems. The Agency concludes that further subdivision based upon wastewater treatability considerations is not justified.

Size and Age of Facilities

The Agency considered the impact of size and age on subdivision of continuous casters. It analyzed possible correlations relating the effects of age and size upon such elements as wastewater flows, wastewater characteristics, and the ability to retrofit treatment equipment to existing facilities. No relationships were found, and size and age were determined to have no impact upon subdivision.

Size has no apparent effect upon subdivision. Analysis does not reveal any correlation between the size of a casting shop and any pertinent factor such as process water usage or wastewater characteristics. Figure IV-1 is a plot of discharge flow rates (in gallons/ton) versus production capacity (in tons/day) for continuous casters. As can be seen by this plot, the size of the caster shop has no bearing upon the ability to recycle and subsequently attain a low discharge flow rate. A review of analytical data for sampled plants (presented in Section VII) does not show any relationship between size and the characteristics of the wastewater generated. Thus, the Agency concludes that further subdivision based upon the size of casting shops is not warranted.

"Age" was examined as a possible basis for subdivision as it relates to feasibility and cost of retrofit (this issue is also discussed in general terms in Section III of Volume I). The concept of age for a casting shop, though, has little meaning, as the casting process is a relatively new development. According to the DCP data, the "oldest" caster now in operation was installed in 1955 with most being built in the 1960's. Accordingly, there is not much variation in the age of the various casting shops. A comparison was made, however, of age and process water usage in a similar manner as was performed for the size of a caster shop. Figure IV-2 illustrates this comparison. As with the flow versus size plots, no relationship is evident. Thus, the age of a shop has no effect upon the ability to recycle process water and attain a low effluent discharge.

Further analysis indicates that the age of a caster shop in no way affects the quality or quantity of wastewaters generated. Older shops generate the same kind and amount of wastewaters as newer shops. In addition, the treatability of these wastes is about the same in all cases.

The Agency also addressed the ability to retrofit water pollution control equipment as part of the age analysis. Several older plants have demonstrated the ability to retrofit equipment as shown in Table IV-1. These examples demonstrate that pollution control equipment can be installed on existing plant facilities. In addition, the Agency analyzed the cost of retrofit to determine whether older plants require greater capital expenditures than newer plants. The D-DCPs solicited this retrofit cost information, and of the nine plants surveyed, none reported any costs due to retrofit. While there were probably some retrofit costs in all cases where wastewater treatment facilities were added to existing casters, based upon the responses received to D-DCPs in this and other subcategories, EPA concludes that such costs are not significant.

Based upon the preceding discussion, neither the size of a casting shop nor its age has any significant effect upon the nature or treatment of the resulting wastewaters. The Agency concludes, therefore, that further subdivision, based upon size or age, is not warranted.

Geographic Location

The location of continuous casting facilities has no apparent effect upon subdivision. The Agency analyzed the relationship between plant location and pertinent factors such as process water use and wastewater characteristics. No discernible pattern was revealed. Most of the plants are located east of the Mississippi River. Six are located in Texas, four in California, and one each in Oklahoma, Colorado, and Oregon. One caster is located in the arid west and requires the use of only minimal quantities of water from a local river. Consideration was given to the consumptive use of water, since the model treatment systems involve the use of evaporative cooling towers. However, the effects due to the consumptive use of water are minimal. As a result, the Agency concludes that further subdivision on the basis of geographic location is not warranted.

Process Water Usage and Discharge Rates

The Agency examined process water usage and discharge rates as a possible factor of subdivision. Table IV-2 presents flow averages and ranges for those plants which supplied flow data. Data were compiled according to the type of steel cast, the type of product cast, the number of strands, and the type of caster. Although the data tend to indicate that specialty casters use less water, the Agency concludes that similar effluent flow rates for carbon and specialty casters can be achieved, based upon industry performance. Therefore, the Agency concludes that further subdivision, based upon process water usage or discharge rates, is not appropriate.

TABLE IV-1

EXAMPLES OF PLANTS THAT HAVE DEMONSTRATED THE ABILITY TO RETROFIT POLLUTION CONTROL EQUIPMENT CONTINUOUS CASTING

Plant Code	Mill Age Year	Treatment Age Year
0284A	1974	1974, 1976
0432A	1969	1974
0476A	1969	1977
0584F	1968	1970, 1973
0652	1968	1971, 1973

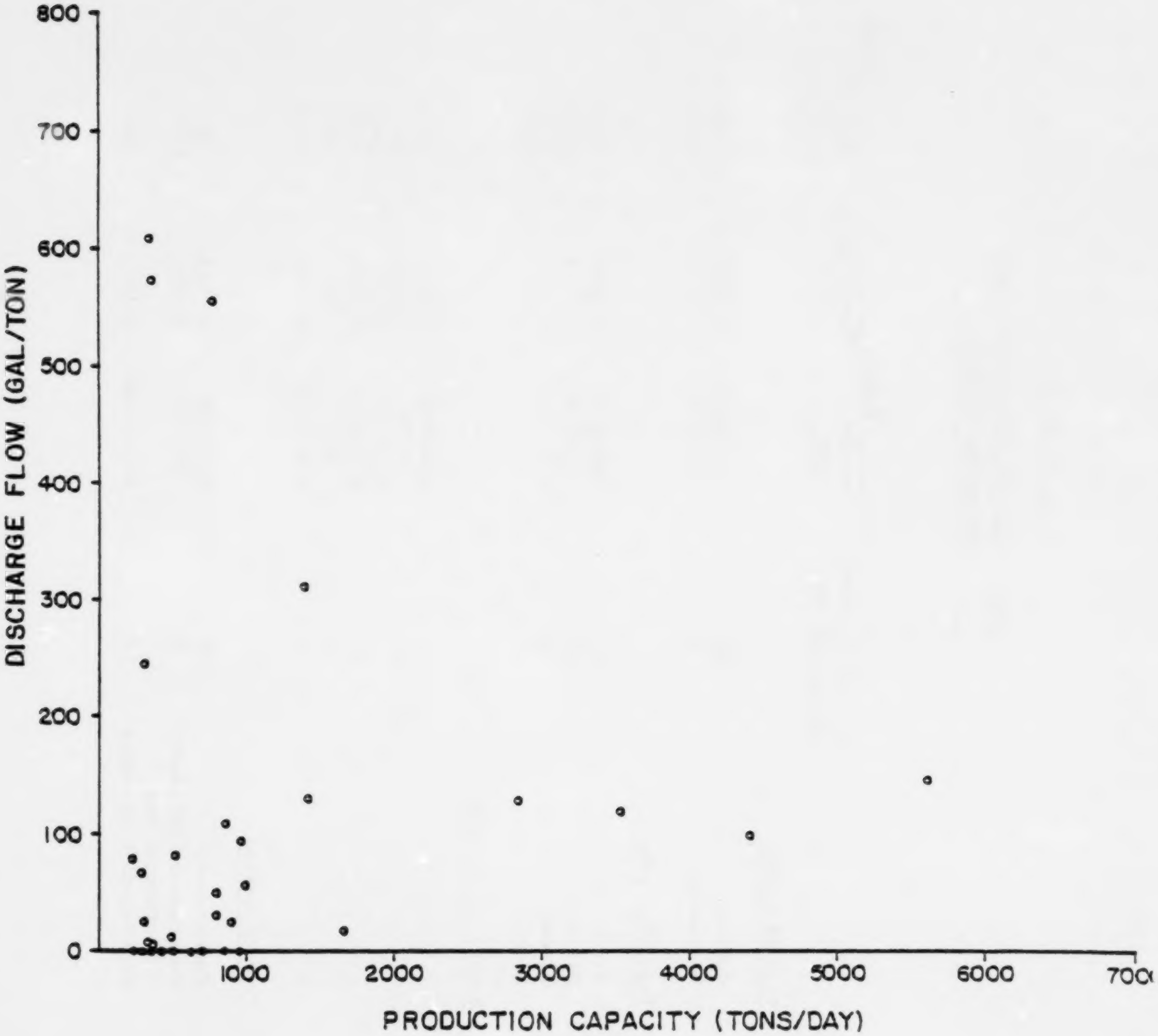
TABLE IV-2

APPLIED AND DISCHARGE FLOW RATES
CONTINUOUS CASTING

	No. of Casters Reporting Data	Range		Average	
		Applied GPT	Discharge GPT	Applied GPT	Discharge GPT
Type of Steel					
Carbon	46	22-16210	0-5489	3646	617
Specialty	5	564-2000	0-554	1409	151
Type of Product					
Slabs	13	564-8258	0-5489	3716	689
Billets	27	22-6111	0-5318	2558	476
Blooms	5	1278-16210	16-1278	6923	487
Rounds	1	3755	79	3755	79
Number of Strands					
1	5	564-8258	0-5489	3642	1160
2	17	22-7062	0-1375	2525	277
3	7	1656-4294	0-245	2662	64
4	11	927-5318	16-5318	3015	894
5	1	5161	0	5161	0
6	5	923-16210	56-1527	5028	373
Type of Caster					
Continuous	31	564-8258	0-2543	2931	401
Continuous-Continuous	6	22-7062	0-5489	4331	1844
Continuous and Continuous-Continuous	15	547-16210	0-128	3537	44

FIGURE IV-1

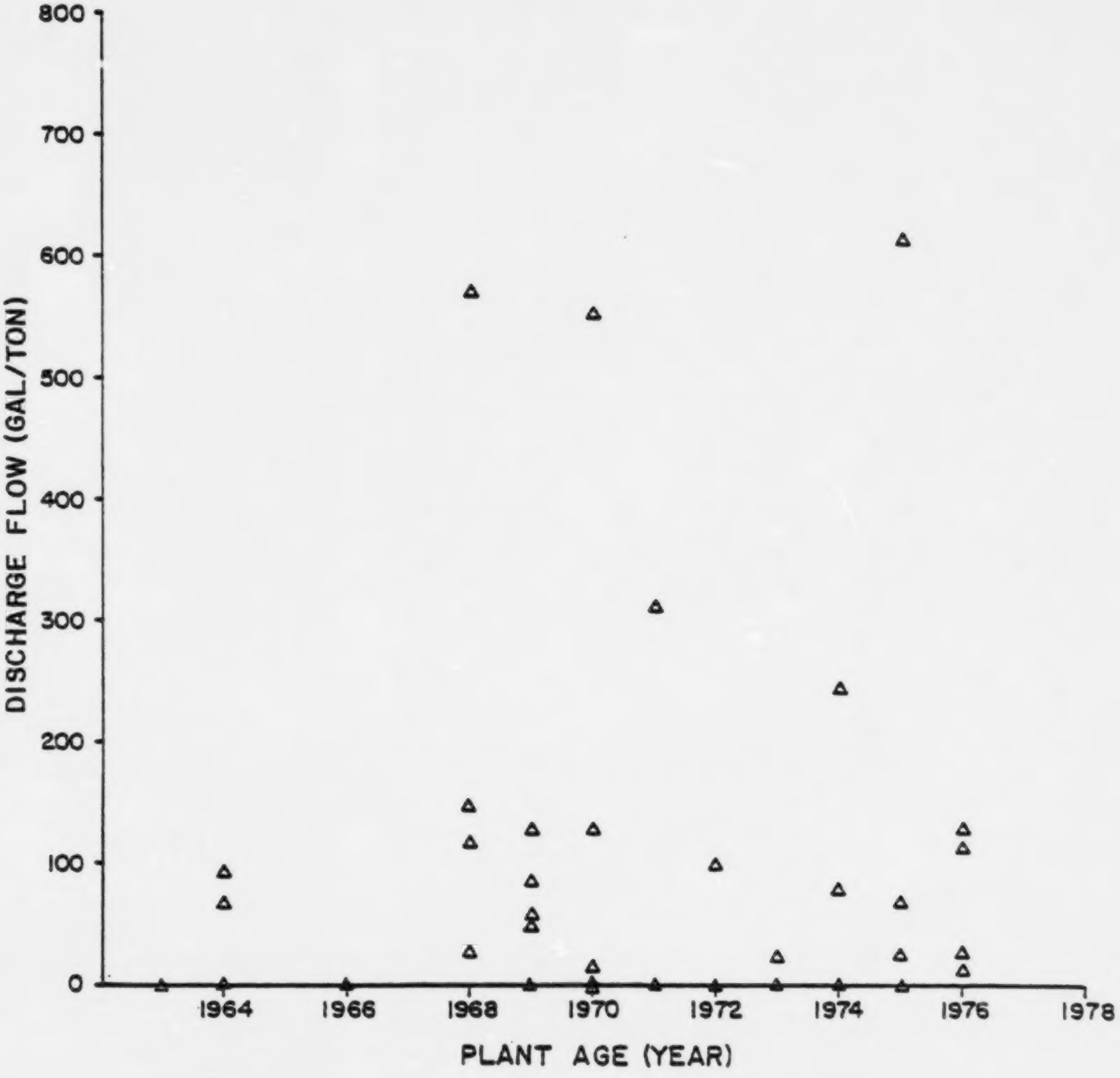
DISCHARGE FLOW vs. PLANT SIZE CONTINUOUS CASTING SUBCATEGORY



SIX PLANTS HAVING DISCHARGE FLOW RATES GREATER THAN 1000 GAL/TON WERE NOT INCLUDED IN THIS FIGURE.

FIGURE IV-2

DISCHARGE FLOW vs. PLANT AGE
CONTINUOUS CASTING SUBCATEGORY



SIX PLANTS HAVING DISCHARGE FLOWS GREATER THAN 1000 GAL/TON WERE NOT INCLUDED IN THIS FIGURE.

CONTINUOUS CASTING SUBCATEGORY

SECTION V

WATER USE AND WASTE CHARACTERIZATION

Introduction

Process water usage and characterization of the wastewaters generated by the continuous casting process are the principal considerations in determining pollutant loads, developing treatment alternatives, and estimating costs. This section describes the water system in use in the continuous casting subcategory and the type of wastes originating from the process. The description of the wastewater system is limited to those streams which come into contact with raw material, products, or by-products associated with the process. This excludes the various noncontact cooling water systems that are used in the continuous casting process. Waste characterization is based upon analytical data obtained during field sampling surveys.

Water Use

The continuous casting process has three main plant water systems.

1. Copper mold noncontact cooling water system
2. Machinery noncontact cooling water system
3. Cast product spray contact cooling water system

Only the cast product spray contact cooling water system is discussed, as the other two systems use noncontact cooling water only.

The cast product is only partially solidified when it emerges from the molds. The interior core of the product is still molten steel at this time. The cast product spray cooling water system sprays water directly onto the product for further cooling. As the cast product surface oxidizes, scale is washed away by the cooling water. The spray water also becomes contaminated with oils and greases which are released by the hydraulic and lubrication systems. As the cast product is discharged on to the run-out tables for final cooling, additional scale flakes off and drops beneath the tables. Sometimes this scale is sluiced to the spray cooling water pit.

Approximately 5-10% of the water sprayed on the product is evaporated with the balance being discharged to a scale pit. Temperatures of discharged spray waters range from 54° to 60°C (130° to 140°F). Other minor wastewater systems include spray cooling of cast product, acetylene torch cut-off, and miscellaneous cooling or sluicing.

In conjunction with the water systems described above, a common industry practice is to recycle the process wastewater. Table X-2 is a list of the plants for which flow and recycle rate data were received. As shown, wastewaters are recycled at the vast majority of plants at rates exceeding ninety percent. Several plants report no discharge of process wastewater from continuous casting operations.

Waste Characterization

The continuous casting process produces scale and oils and greases as a result of the spray cooling process. Withdrawal and guide rolls guide the cast product through the solidification stage. Since the cast product is hot, the surface oxidizes and the resulting scale is washed out with the spray cooling water. Additional scale flakes off when the cast product is discharged onto the caster run-out tables. Caster equipment employs hydraulic and lubrication systems which add oils and greases to the wastewaters.

The raw wastewater discharges from the carbon and specialty steel continuous casters are similar in waste characterization with regard to the previously limited pollutants, suspended solids, oil and grease, and pH. Tables V-1 and V-2 present raw wastewater flow and quality data for the plants sampled. The wastewater pollutant concentration data represent the contribution of pollutants from each pass through the casting process. Data for Plant AE, sampled during the original guidelines survey, are not presented, since this operation was resampled as Plant 075 during the toxic pollutant survey. The toxic pollutant survey data are more complete and more representative of current plant operations.

The analytical data presented in Table V-2 show the type and quantity of organic compounds and toxic metals which have been found in continuous casting wastewaters. Section VI deals more specifically with the selection of pollutants, in terms of regulation, monitoring, and the origin of these pollutants.

TABLE V-1

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
CONTINUOUS CASTING

Net Concentration of Pollutants in Raw Wastewater

Reference Code	0868B	0684D	Average
Plant Code	AF	Q	
Sample Point(s)	7-9	16	
Flow, gal/ton	1475	-	1475
	mg/l	mg/l	mg/l
Suspended Solids	89	126	108
Oil and Grease	22	16.3	19
pH (Units)	6.6	8.9	6.6-8.9
Chromium	NA	0.060	0.060
Copper	0.12	0.020	0.070
Lead	-	NA	-
Zinc	1.0	0.040	0.52

- : Calculation yielded a negative result.
NA: Not analyzed

NOTE: Plant B, a pressure slab caster, is not addressed here as it was scheduled for shutdown in September of 1980.
Raw wastewater data for Plant D was unobtainable during sampling.

TABLE V-2

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
CONTINUOUS CASTING

Net Concentration of Pollutants in Raw Wastewater

Reference Code		0284A	0496	0584F	0060K	Toxic	
Plant Code		071	072	075	079	Survey	Overall(1)
Sample Point(s)		B-C	F-E	I+K-J-A	C-B-E	Average	Average
Flow, gal/ton		564	1542	3489	2985	2145	2011
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	Total Suspended Solids	-	16.5	-	11	6.9	40
	Oil & Grease	3.8	19	3.6	4	7.6	11.5
	pH (Units)	9.2-9.4	7.4-8.1	7.0-9.2	7.0-7.9	7.0-9.4	6.6-9.4
022	Parachlorometacresol	0.11	-	0.000018	0.005	0.03	0.03
023	Chloroform	0.0017	-	0.017	-	0.0047	0.0047
034	2,4-Dimethylphenol	0.025	ND	0.007	ND	0.008	0.008
039	Fluoranthene	ND	0.003	ND	0.019	0.0055	0.0055
068	Di-n-butyl phthalate	-	0.0034	-	0.039	0.011	0.011
069	Di-n-octyl phthalate	0.02	-	0.016	0.18	0.054	0.054
086	Toluene	-	-	0.016	0.0039	0.005	0.005
119	Chromium	-	-	-	-	-	0.012
120	Copper	0.015	-	-	-	0.0038	0.027
122	Lead	-	-	0.006	-	0.0015	0.0012
125	Selenium	0.22	-	-	NA	0.073	0.073
128	Zinc	-	-	-	-	-	0.17

- : Calculation yielded a negative result.
ND: Not detected
NA: Not analyzed

(1) Overall averages include the values presented on Table V-1.

CONTINUOUS CASTING SUBCATEGORY

SECTION VI

WASTEWATER POLLUTANTS

Introduction

This section describes the rationale for selecting, and discusses process sources of those pollutants for which limitations are proposed for continuous casting operations.

Final selection of those pollutants was based upon an analysis of wastewater samples collected during plant visits. This list of pollutants was confirmed and augmented through extensive field sampling that included analysis for toxic pollutants. On the basis of the expected and observed similarities among continuous casting operations, the list of selected pollutants was developed.

Conventional Pollutants

The previously limited pollutants, suspended solids, oil and grease, and pH, were chosen based on the nature of the raw materials and equipment used in the casting process. Suspended solids was chosen because a large quantity of scale is generated by the casting process and carried out by the spray cooling waters. When scale comes into contact with cooling water, the particulates are transferred to the wastewater. It should be noted that the suspended solids level also indicates the degree to which the process water has been contaminated. Toxic metals are often entrained with solids suspended in the wastewater. The removal of solids often results in removal of toxic metals.

The Agency selected oil and grease for limitation, because it is often found in caster wastewaters. Lubrication is a necessary part of the continuous casting process. Oil spills, line breaks, excessive application of lubricants, and equipment washdown all contribute to the presence of oil and grease in continuous casting wastewaters.

Finally, the Agency chose pH, a measure of the acidity or alkalinity of a wastewater, because of the environmentally detrimental effects which can result from extremes in pH. In addition, corrosion and scaling conditions, which foul or damage process or treatment equipment, can be caused by extreme pH levels. The pH of continuous casting process wastewaters typically falls within the range of 6.0 to 9.0 standard units.

Toxic Pollutants

This study was also directed at evaluating toxic pollutant discharges. The toxic pollutants analyzed during the verification sampling phase of the project included those pollutants which were classified by the Agency as "known to be present." This determination was made as a result of industry responses to the DCPs and analyses performed during the screening phase. Table VI-1 lists those toxic pollutants for which analyses were performed. A final toxic pollutant list was compiled by including all pollutants which were detected in the raw wastewater at an average concentration of 0.010 mg/l or greater. This list is presented in Table VI-2 for the continuous casting subcategory and includes the previously discussed limited pollutants. The pollutants listed in Table VI-2 are considered to be those which are most representative and indicative of casting operations, and they are addressed accordingly throughout this report.

Toxic metal pollutants originate in the molten steels which are cast. These metals find their way into the wastewaters through the scale particulates which are washed from the cast product. Three organic pollutants, parachlorometacresol, di-n-butyl phthalate, and di-n-octyl phthalate, were also detected in caster wastewaters at significant levels. The phthalate compounds, however, are not believed to be characteristic of the casting process. Evidence developed during the sampling inspections indicates that their origin is probably related to plasticizers in the tubing used for the automatic collection of samples. With respect to parachlormetacresol, it appears in concentrations that, aside from recycle, are below treatability levels. For these reasons, the Agency is not proposing limitations for this pollutant. The Agency believes that this pollutant does not tend to concentrate in recycle systems. Although the concentrations of these pollutants in recycle system blowdowns will be approximately the same as in the discharge from once-through systems, the mass loadings of these pollutants will be reduced proportionately to the degree of recycle. Accordingly, with the high degree of recycle incorporated in the BAT, BCT, NSPS, PSES, and PSNS technologies, the Agency believes that compliance with the proposed limitations and standards for conventional and toxic metal pollutants will indicate a comparable reduction in the discharge of those toxic organic pollutants present in continuous casting wastewaters.

TABLE VI-1

TOXIC POLLUTANTS KNOWN TO BE PRESENT CONTINUOUS CASTING

Toxic Pollutant Numeric Designation	Pollutant Parameter
22	Parachlorometacresol
23	Chloroform
34	2,4-Dimethylphenol
39	Fluoranthene
68(1)	Di-n-butyl phthalate
69(1)	Di-n-octyl phthalate
86	Toluene
119	Chromium
120	Copper
122	Lead
125	Selenium
128	Zinc

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(1) Appearance of this pollutant in continuous casting wastewater is believed to be due to plasticizers found in sampling equipment.

TABLE VI-2

SELECTED POLLUTANT PARAMETERS CONTINUOUS CASTING

	Total Suspended Solids
	Oil and Grease
	pH
119	Chromium
120	Copper
122	Nickel
125	Selenium
128	Zinc

CONTINUOUS CASTING SUBCATEGORY

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

Introduction

The Agency established the BPT, BAT, BCT, PSES, PSNS, and NSPS alternative treatment systems after determining the current level of treatment in the industry. The various treatment technologies were then formulated as "add-ons" to this primary level of treatment. Control and treatment technologies available for the various levels of treatment are discussed in this section. The Agency is proposing effluent limitations and standards for these levels of treatment based upon an evaluation of the effluent analytical data obtained during plant visits and treatment capabilities demonstrated in this or other subcategories. Treatment system summaries, schematics, and wastewater analytical data for the visited plants are presented herein.

Summary of Treatment Practices Currently Employed

The wastewater produced by the continuous casting process primarily results from the spray water system which brings cooling water into contact with the hot semi-finished product. This wastewater requires treatment.

The basic treatment systems in use at continuous casting plants include primary settling devices, which are often scale pits equipped with drag link conveyors and oil removal facilities. The scale pit overflow is often treated in settling lagoons, filters, or clarifiers. The treated water is then recycled through cooling towers with a small blowdown being discharged. (About 25 percent of the industry, however, have no such discharge and recycle 100% of the wastewater.) Cooling towers are used to reduce the process water temperature prior to recycle. Chemical flocculation systems are provided with clarifiers to aid in the settling of solids. Clarifier underflows are then dewatered by vacuum filters or centrifuges.

Several different types of filters are used. Flat bed filters, with disposable filter belts, or deep bed filters are often used. The deep bed filters require backwashing to clean the filter media. Flat bed filters use a media which is disposed of along with the solids filtered. The deep bed filters discharge backwash waters to sludge tanks. Filtered solids are then disposed of in landfills. The capital cost of flat bed filters is approximately 1/3 that of deep bed filters. In addition, flat bed filters do not require the backwashing and other equipment necessary to operate deep bed filters effectively. Four casting plants presently use flat bed filters. Thirteen plants employ deep bed filters, but nine of these plants use central treatment systems. In these cases, the deep bed filters treat other wastewaters in addition to continuous casting wastewaters. Filtration of the continuous casting discharge will remove toxic metals entrained in the suspended solids, as those metals are in particulate form rather than in a dissolved state.

Table III-2 presents the treatment technologies and modes of operation for all caster plants.

Control and Treatment Technologies Considered for Toxic Pollutant Removal

The detection of toxic metals in continuous casting wastewaters required the consideration of additional treatment for BAT, NSPS, PSES, and PSNS. The technology selected for review, in addition to filtration as noted above, is sulfide precipitation. A brief discussion of this technology follows.

Systems which include the addition of a sulfide compound to the wastewaters have been shown to be capable of reducing toxic metal pollutant concentrations substantially below the levels achieved in lime flocculaton precipitation reactions. Some of the toxic metals which can be precipitated effectively with sulfide are zinc, copper, chromium, lead, and selenium. The increased removal efficiencies can be attributed to the comparative solubilities of metal sulfides with metal hydroxides. In general, the metal sulfide is less soluble than the hydroxide form of the same metal. However, it is important to note that an excess of sulfide in a treated effluent can result in objectionable odor problems. A decrease in wastewater pH will aggravate this problem. If wastewater treatment pH control problems result in even a slight pH variance, operating personnel may become affected. One method of controlling excess sulfide is by feeding a solution of iron sulfide. Iron sulfide will not readily disassociate in the waste stream to excess sulfide ions. However, the affinities of the other metals for sulfide are great enough to form precipitates by using iron sulfide. Sulfide is fed in much the same manner as lime and is often used in conjunction with a filter downstream.

Summary of Sampling Visit Data

The Agency visited seven continuous casting facilities during the overall study. Four of these plants were visted for the original study, and four were surveyed during the latter toxic pollutant study. Four of the seven plants are carbon steel casters, and three are specialty steel casters. One plant was sampled twice; Plant AE for the original study and Plant 075 for the toxic pollutant study. This plant is addressed as Plant 075, since the data obtained during the second study are considered to be more representative of present operations.

Table VII-1 provides a legend for the various control and treatment technology abbreviations used throughout this report. Tables VII-2 and VII-3 present the raw and effluent waste loads for the above mentioned continuous casting plants. Figures VII-1 through VII-7 are wastewater treatment schematics of the plants sampled. A brief description of the treatment practices and facilities at each of the sampled plants follows.

Plant AF - Figure VII-1

Wastewater from the continuous caster at this plant is treated together with vacuum degassing wastewater. Treatment consists of a scale pit with oil skimming, high flow rate pressure filters, a cooling tower, and a recycle pump system. Blowdown is less then 2 percent of the applied flow. Deep bed filters are used with the backwash waters being discharged to the caster scale pit.

Plant D - Figure VII-2

Caster wastewater is first settled in a clarifier. The clarifier underflow is batch discharged to the river, while the overflow is pumped through a filter and then recycled to the process.

Plant Q - Figure VII-3

Caster sprays are discharged to a collection sump for settling and then pumped to a cooling tower. Water is recycled from the cooling tower to the process. There is no discharge from this system.

Plant 071 - Figure VII-4

This plant uses a scale pit and pressure sand filters to remove solids from the caster machine spray waters. Filter backwash is discharged to a sludge concentrator. Sludge is hauled away by a contractor, and the concentrator overflow is returned to the scale pit. Filtered water is recycled to the caster sprays after passing through a cooling tower. There is no discharge from this system.

Plant 072 - Figure VII-5

This plant uses a combination treatment system for its vacuum degasser and continuous caster. Caster wastewater is discharged to a scale pit which receives degasser wastewater as well. The wastewater is then recirculated through a cooling tower to pressure sand filters. Backwash waters are discharged to the scale pit, which overflows to a large lagoon or reservoir. Filter effluent is passed through another cooling tower and finally recycled to the process. Aside from filter backwash, this system achieves zero discharge, since all of the wastewaters are recirculated.

Plant 075 - Figure VII-6

Plant 075 was originally sampled in 1974 as Plant AE. Modifications to its treatment system justified the revisit. Caster wastewater is first pumped to primary scale pits. Some water is recycled to the process from there, but most of it is passed through flat bed filters. A blowdown from the filters is discharged to lagoons. The filter effluent is recirculated through a cooling tower and then pumped to walnut shell deep bed filters. The backwash is discharged to the lagoons, as the filter effluent is recycled to the caster sprays. Recycle is approximately 97 percent of the process flow.

Plant 079 - Figure VII-7

This plant uses flat bed filters and recycle with 0.8% blowdown to a scale pit, which serves as a final settling pond. Filtered water is recycled to the caster after passing through a cooling tower.

TABLE VII-1

OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS

Symbols

A. Operating Modes

1. OT Once-Through

2. Rt,s,n Recycle, where t = type waste
s = stream recycled
n = % recycled

t: U = Untreated
T = Treated

	s	n
P	Process Wastewater	% of raw waste flow
F	Flume Only	% of raw waste flow
S	Flume and Sprays	% of raw waste flow
FC	Final Cooler	% of FC flow
BC	Barometric Cond.	% of BC flow
VS	Abs. Vent Scrub.	% of VS flow
FH	Fume Hood Scrub.	% of FH flow

3. REt,n Reuse, where t = type
n = % of raw waste flow

t: U = before treatment
T = after treatment

4. BDn Blowdown, where n = discharge as % of raw waste flow

B. Control Technology

10. DI Deionization

11. SR Spray/Fog Rinse

12. CC Countercurrent Rinse

13. DR Drag-out Recovery

C. Disposal Methods

20. H Haul Off-Site

21. DW Deep Well Injection

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 2

C. Disposal Methods (cont.)

22.	Qt,d	Coke Quenching, where t = type d = discharge as % of makeup t: DW = Dirty Water CW = Clean Water
23.	EME	Evaporation, Multiple Effect
24.	ES	Evaporation on Slag
25.	EVC	Evaporation, Vapor Compression Distillation

D. Treatment Technology

30.	SC	Segregated Collection
31.	E	Equalization/Blending
32.	Scr	Screening
33.	OB	Oil Collecting Baffle
34.	SS	Surface Skimming (oil, etc.)
35.	PSP	Primary Scale Pit
36.	SSP	Secondary Scale Pit
37.	EB	Emulsion Breaking
38.	A	Acidification
39.	AO	Air Oxidation
40.	GF	Gas Flotation
41.	M	Mixing
42.	Nt	Neutralization, where t = type t: L = Lime C = Caustic A = Acid W = Wastes O = Other, footnote

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 3

D. Treatment Technology (cont.)

43.	FLt	Flocculation, where t = type t: L = Lime A = Alum P = Polymer M = Magnetic O = Other, footnote
44.	CY	Cyclone/Centrifuge/Classifier
44a.	DT	Drag Tank
45.	CL	Clarifier
46.	T	Thickener
47.	TP	Tube/Plate Settler
48.	SLn	Settling Lagoon, where n = days of retention time
49.	BL	Bottom Liner
50.	VF	Vacuum Filtration (of e.g., CL, T, or TP underflows)
51.	Ft,m,h	Filtration, where t = type m = media h = head

t	m	h
D = Deep Bed	S = Sand	G = Gravity
F = Flat Bed	O = Other, footnote	P = Pressure

52.	CLt	Chlorination, where t = type t: A = Alkaline B = Breakpoint
53.	CO	Chemical Oxidation (other than CLA or CLB)

D. Treatment Technology (cont.)

54.	BOt	Biological Oxidation, where t = type t: An = Activated Sludge n = No. of Stages T = Trickling Filter B = Biodisc O = Other, footnote
55.	CR	Chemical Reduction (e.g., chromium)
56.	DP	Dephenolizer
57.	ASt	Ammonia Stripping, where t = type t: F = Free L = Lime C = Caustic
58.	APt	Ammonia Product, where t = type t: S = Sulfate N = Nitric Acid A = Anhydrous P = Phosphate H = Hydroxide O = Other, footnote
59.	DSt	Desulfurization, where t = type t: Q = Qualifying N = Nonqualifying
60.	CT	Cooling Tower
61.	AR	Acid Regeneration
62.	AU	Acid Recovery and Reuse
63.	ACt	Activated Carbon, where t = type t: P = Powdered G = Granular
64.	IX	Ion Exchange
65.	RO	Reverse Osmosis
66.	D	Distillation

TABLE VII-1
OPERATING MODES, CONTROL AND TREATMENT TECHNOLOGIES AND DISPOSAL METHODS
PAGE 5

D. Treatment Technology (cont.)

67.	AA1	Activated Alumina
68.	OZ	Ozonation
69.	UV	Ultraviolet Radiation
70.	CNTt,n	Central Treatment, where t = type n = process flow as % of total flow t: 1 = Same Subcats. 2 = Similar Subcats. 3 = Synergistic Subcats. 4 = Cooling Water 5 = Incompatible Subcats.
71.	On	Other, where n = Footnote number
72.	SB	Settling Basin
73.	AE	Aeration
74.	PS	Precipitation with Sulfide

TABLE VII-2

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
ORIGINAL GUIDELINES SURVEY
CONTINUOUS CASTING

Raw Wastewaters

Reference Code	0868B		0248B		0684D		Average	
Plant Code	AF		D		Q			
Sample Point	7		(1)		16			
Flow (gal/ton)	1475		*		(2)		1475	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	111	0.683	*	*	126	*	118.5	0.683
Oil and Grease	22.5	0.138	*	*	16.3	*	19.4	0.138
pH (Units)	6.6		*		8.9		6.6-8.9	
Chromium	*	*	*	*	0.060	*	0.060	*
Copper	0.37	0.0023	*	*	0.020	*	0.195	0.0023
Lead	0.15	0.00092	*	*	*	*	0.15	0.00092
Zinc	2.6	0.016	*	*	0.040	*	1.32	0.016

Effluents

Reference Code	0868B		0248B		0684D	
Plant Code	AF		D		Q	
Sample Point	9		*		16	
Flow (gal/ton)	17		0		0	
C&TT	PSP,SS,FDSP,CT,RTP98.8,BD1.2		CL,FP,RTP100		PSP,CT,RTP100	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	22	0.0016	*	0	126	0
Oil and Grease	0.5	0.000035	*	0	16.3	0
pH (Units)	6.8		*		8.9	
Chromium	*	*	*	0	0.060	0
Copper	0.25	0.000018	*	0	0.020	0
Lead	0.43	0.000030	*	0	*	0
Zinc	1.6	0.00011	*	0	0.040	0

---

* Insufficient data.

(1) Raw wastewater data for this plant was unobtainable during sampling.
(2) Flow value (gal/ton) could not be calculated due to insufficient tonnage information.

TABLE VII-3

SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
CONTINUOUS CASTING

Raw Wastewater

Reference Code	0284A		0496		0584F		0060K					
Plant Code	071		072		075(1)		079				Overall	
Sample Point	B		F		I		C		Average		Average	
Flow (gal/ton)	564		1542		3489		2985		2145		2011	
	mg/1	lbs/1000 lbs	mg/1	lbs/1000 lbs	mg/1	lbs/1000 lbs	mg/1	lbs/1000 lbs	mg/1	lbs/1000 lbs	mg/1	lbs/1000 lbs
Suspended Solids	6.3	0.015	36	0.23	13	0.19	48	0.60	26	0.26	57	0.34
Oil & Grease	10	0.024	26	0.17	17	0.25	39	0.49	23	0.23	22	0.21
pH (Units)	9.2		7.4-7.9		7.9-8.3		7.0-7.2		7.0-9.2		6.6-9.2	
Chromium	1.00	0.0024	0.0080	0.000051	2.00	0.029	0.023	0.00029	0.76	0.0079	0.62	0.0079
Copper	0.087	0.00020	0.020	0.00013	0.026	0.00038	0.16	0.0020	0.073	0.00068	0.11	0.0010
Lead	0.10	0.00024	0.070	0.00045	0.060	0.00087	0.070	0.00087	0.075	0.00061	0.09	0.00067
Selenium	0.22	0.00052	0.010	0.000064	0.0020	0.000029	*	*	0.077	0.00020	0.077	0.00020
Zinc	0.20	0.00047	0.30	0.0019	0.74	0.011	0.20	0.0025	0.36	0.0040	0.68	0.0064

TABLE VII-3
SUMMARY OF ANALYTICAL DATA FROM SAMPLED PLANTS
TOXIC POLLUTANT SURVEY
CONTINUOUS CASTING
PAGE 2

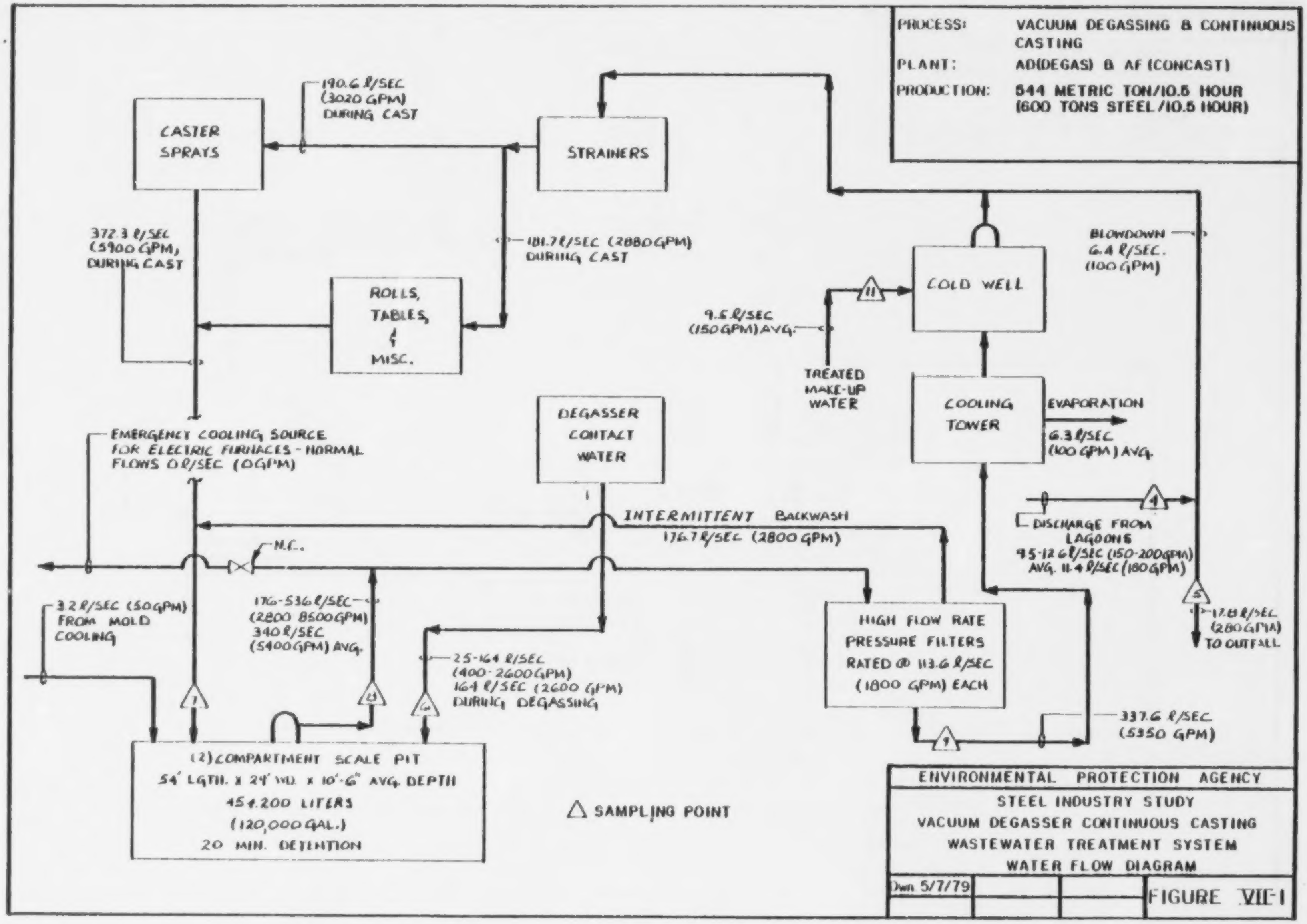
	Effluents							
Reference Code	0284A		0496		0584F		0060K	
Plant Code	071		072		075		079	
Sample Point	C		E		J(2)(3)		B(4)(5)	
Flow (gal/ton)	0		0		117		25	
C&TT	PSP,FSP,T,CT,RTP100		PSP,FDSP,CT,RTP100		PSP,FFP,CT,RTP97		PSP,FF,CT,RTP99.2	
	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs	mg/l	lbs/1000 lbs
Suspended Solids	8	0	16	0	15	0.098	37	0.0050
Oil & Grease	6	0	6	0	18	0.061	35	0.0041
pH (Units)	9.4		7.6-8.1		7.4-7.7		7.1-7.2	
Chromium	1.00	0	0.026	0	2.00	0.00098	0.033	0.0000024
Copper	0.070	0	0.21	0	0.015	0.000036	0.17	0.000017
Lead	0.10	0	0.060	0	0.060	0.00016	0.11	0.0000073
Selenium	0.005	0	0.010	0	0.0023	0.0000012	*	*
Zinc	0.200	0	0.33	0	0.967	0.0010	0.23	0.000021

---

* : No analysis.
ND: Not detected.

(1) Raw wastewater quality is after primary settling and partial recycle.
(2) The concentrations shown are for the filter effluent (sample point J).
(3) The lbs/1000 lbs shown are the total pounds leaving the system as a result of the filter effluent, J, and the filter backwash, K.
(4) The concentrations shown are for the filter effluent (sample point B).
(5) The lbs/1000 lbs shown are the actual pounds leaving the system by way of the caster pit.

NOTE: Refer to Table VII-1 for C&TT Codes definitions.



PROCESS: VACUUM DEGASSING & CONTINUOUS CASTING
PLANT: AD(DEGAS) & AF (CONCAST)
PRODUCTION: 544 METRIC TON/10.5 HOUR (600 TONS STEEL/10.5 HOUR)
CASTER SPRAYS
190.6 ℓ/SEC (3020 GPM) DURING CAST
STRAINERS
372.3 ℓ/SEC (5900 GPM, DURING CAST
181.7 ℓ/SEC (2880 GPM) DURING CAST
ROLLS, TABLES, & MISC.
BLOWDOWN 6.4 ℓ/SEC. (100 GPM)
COLD WELL
11
9.5 ℓ/SEC (150 GPM) AVG.
TREATED MAKE-UP WATER
COOLING TOWER
EVAPORATION
6.3 ℓ/SEC (100 GPM) AVG.
DEGASSER CONTACT WATER
EMERGENCY COOLING SOURCE FOR ELECTRIC FURNACES - NORMAL FLOWS 0 ℓ/SEC (0 GPM)
INTERMITTENT BACKWASH 176.7 ℓ/SEC (2800 GPM)
4
DISCHARGE FROM LAGOONS 9.5-12.6 ℓ/SEC (150-200 GPM) AVG. 11.4 ℓ/SEC (180 GPM)
N.C.
5
17.8 ℓ/SEC (280 GPM) TO OUTFALL
3.2 ℓ/SEC (50 GPM) FROM MOLD COOLING
176-536 ℓ/SEC (2800 8500 GPM) 340 ℓ/SEC (5400 GPM) AVG.
HIGH FLOW RATE PRESSURE FILTERS RATED @ 113.6 ℓ/SEC (1800 GPM) EACH
1
3
6
25-164 ℓ/SEC (400-2600 GPM) 164 ℓ/SEC (2600 GPM) DURING DEGASSING
9
337.6 ℓ/SEC (5350 GPM)
(2) COMPARTMENT SCALE PIT 54' LGTH. x 24' WD. x 10'-6" AVG. DEPTH 454,200 LITERS (120,000 GAL.) 20 MIN. DETENTION
△ SAMPLING POINT
Dwn 5/7/79

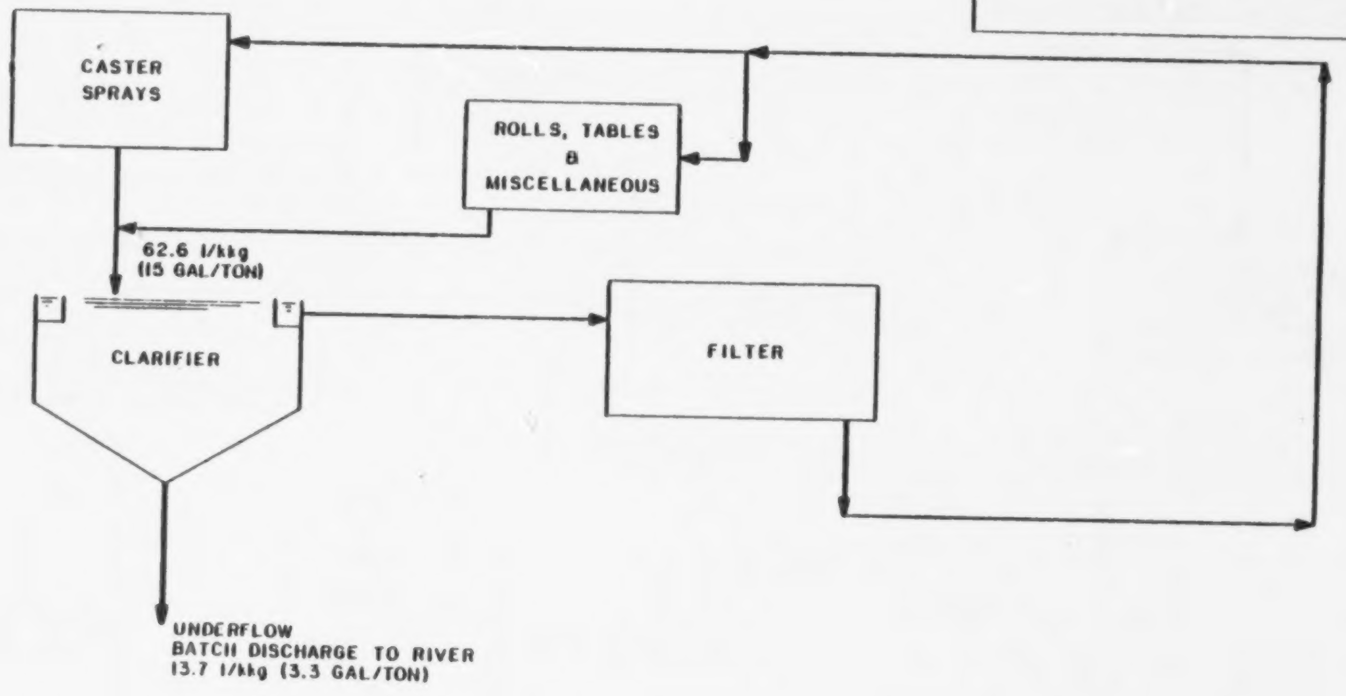
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
VACUUM DEGASSER CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

FIGURE VII-1

PROCESS: CONTINUOUS CASTING

PLANT: D

PRODUCTION:


CASTER SPRAYS
ROLLS, TABLES & MISCELLANEOUS
62.6 l/kkg
(15 GAL/TON)
CLARIFIER
FILTER
UNDERFLOW
BATCH DISCHARGE TO RIVER
13.7 l/kkg (3.3 GAL/TON)

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

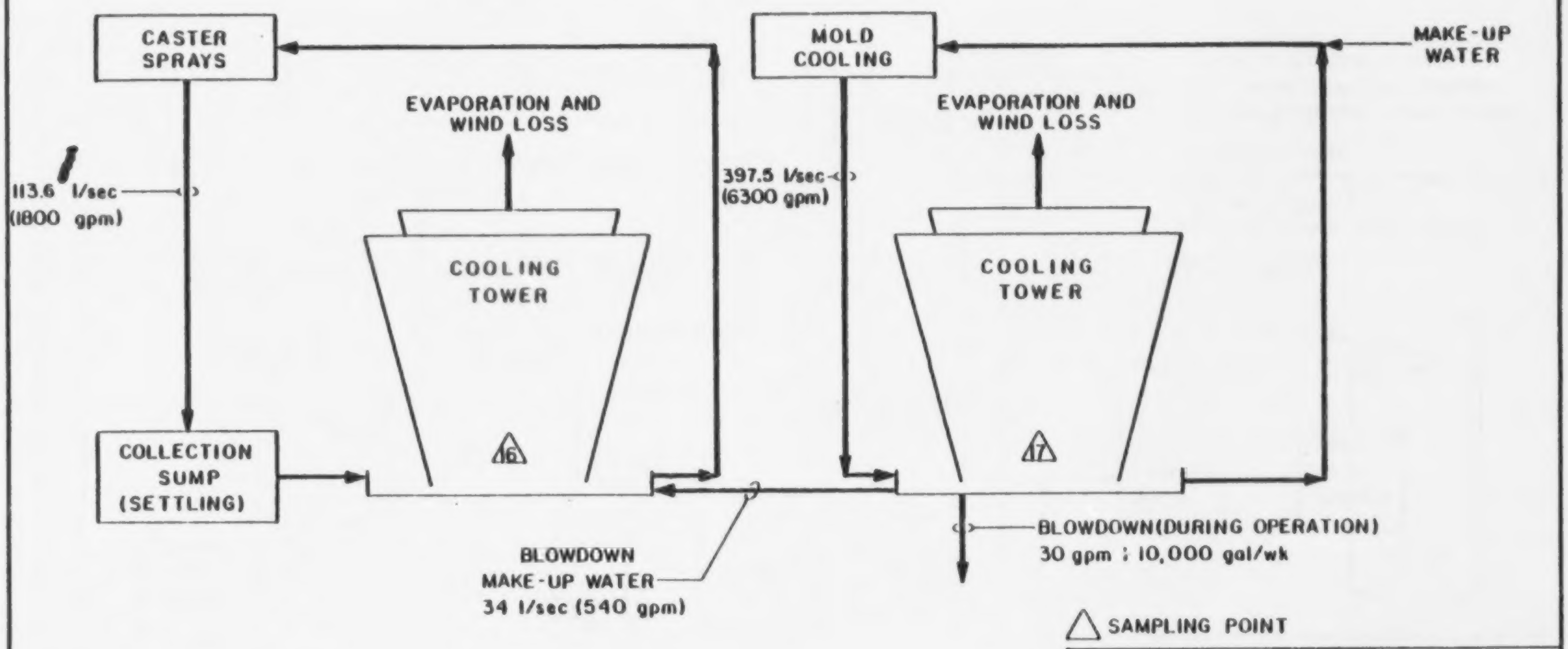
DWN. 2/22/75

FIGURE VII-2

PROCESS: CONTINUOUS CASTING

PLANT: Q

PRODUCTION: 508.8 METRIC TONS STEEL/DAY
(561 TONS STEEL/DAY)

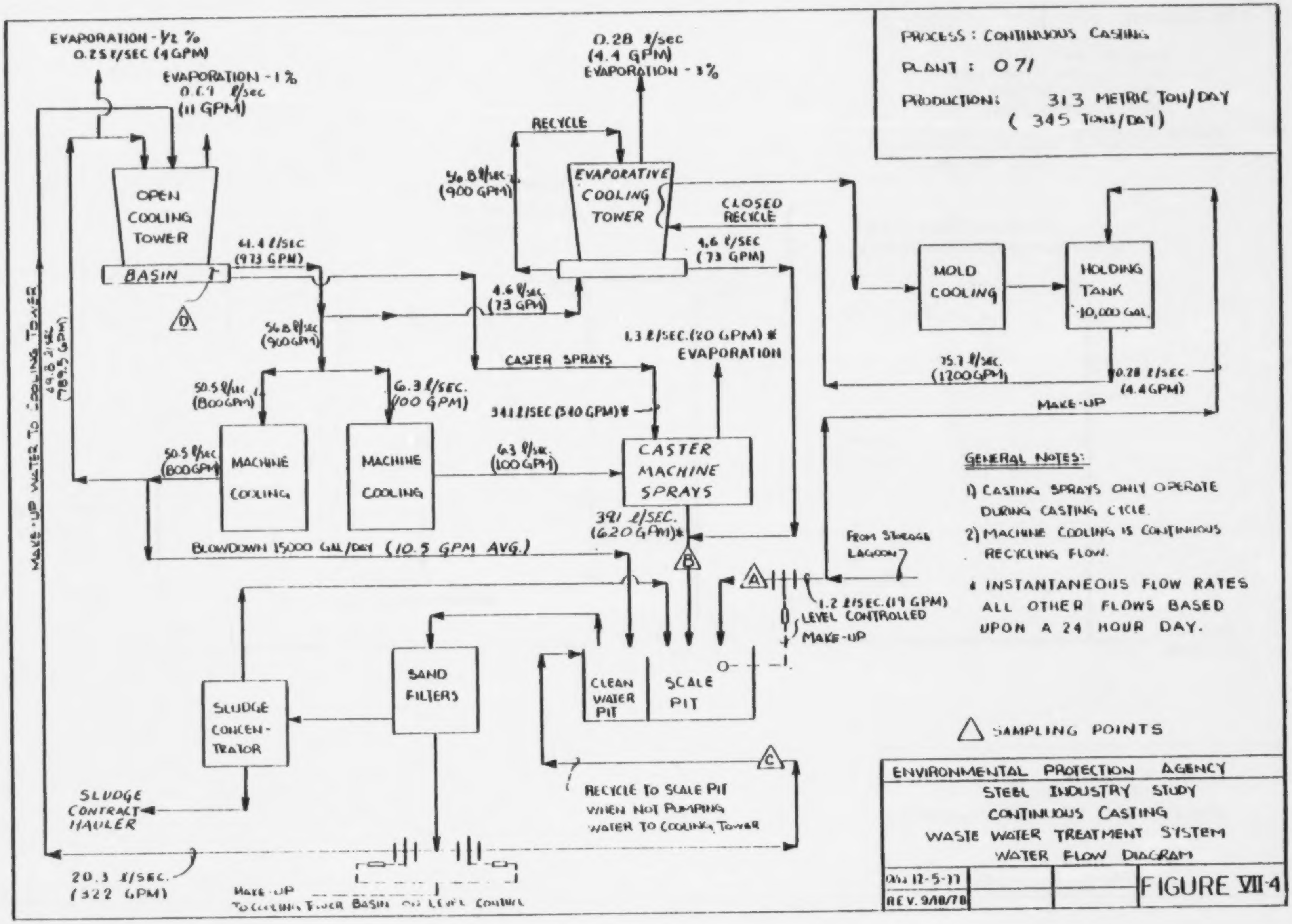

CASTER SPRAYS
113.6 l/sec (1800 gpm)
COLLECTION SUMP (SETTLING)
EVAPORATION AND WIND LOSS
COOLING TOWER
16
397.5 l/sec (6300 gpm)
MOLD COOLING
EVAPORATION AND WIND LOSS
COOLING TOWER
17
MAKE-UP WATER
BLOWDOWN MAKE-UP WATER 34 l/sec (540 gpm)
BLOWDOWN (DURING OPERATION) 30 gpm ; 10,000 gal/wk
SAMPLING POINT

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

Dwn. 2/22/79

FIGURE VII-3


EVAPORATION - 1/2 %
0.25 ℓ/SEC (4 GPM)
EVAPORATION - 1%
0.69 ℓ/sec
(11 GPM)
OPEN COOLING TOWER
BASIN
D
61.4 ℓ/SEC
(973 GPM)
56.8 ℓ/SEC
(900 GPM)
50.5 ℓ/SEC
(800 GPM)
6.3 ℓ/SEC.
(100 GPM)
50.5 ℓ/SEC
(800 GPM)
MACHINE COOLING
MACHINE COOLING
63 ℓ/SEC.
(100 GPM)
RECYCLE
0.28 ℓ/sec
(4.4 GPM)
EVAPORATION - 3%
56.8 ℓ/SEC
(900 GPM)
EVAPORATIVE COOLING TOWER
CLOSED RECYCLE
4.6 ℓ/SEC
(73 GPM)
4.6 ℓ/SEC
(73 GPM)
CASTER SPRAYS
1.3 ℓ/SEC. (20 GPM) *
EVAPORATION
34.1 ℓ/SEC (540 GPM) *
CASTER MACHINE SPRAYS
391 ℓ/SEC.
(620 GPM) *
B
MOLD COOLING
HOLDING TANK 10,000 GAL.
75.7 ℓ/SEC.
(1200 GPM)
0.28 ℓ/SEC.
(4.4 GPM)
MAKE-UP
FROM STORAGE LAGOON
A
1.2 ℓ/SEC. (19 GPM)
LEVEL CONTROLLED
MAKE-UP
BLOWDOWN 15000 GAL/DAY (10.5 GPM AVG.)
CLEAN WATER PIT
SCALE PIT
SAND FILTERS
SLUDGE CONCENTRATOR
SLUDGE CONTRACT HAULER
C
RECYCLE TO SCALE PIT WHEN NOT PUMPING WATER TO COOLING TOWER
MAKE-UP WATER TO COOLING TOWER
49.8 ℓ/SEC
(789.5 GPM)
20.3 ℓ/SEC.
(322 GPM)
MAKE-UP
TO COOLING TOWER BASIN ON LEVEL CONTROL

PROCESS: CONTINUOUS CASTING

PLANT: 071

PRODUCTION: 313 METRIC TON/DAY
(345 TONS/DAY)

GENERAL NOTES:

1) CASTING SPRAYS ONLY OPERATE DURING CASTING CYCLE.
2) MACHINE COOLING IS CONTINUOUS RECYCLING FLOW.

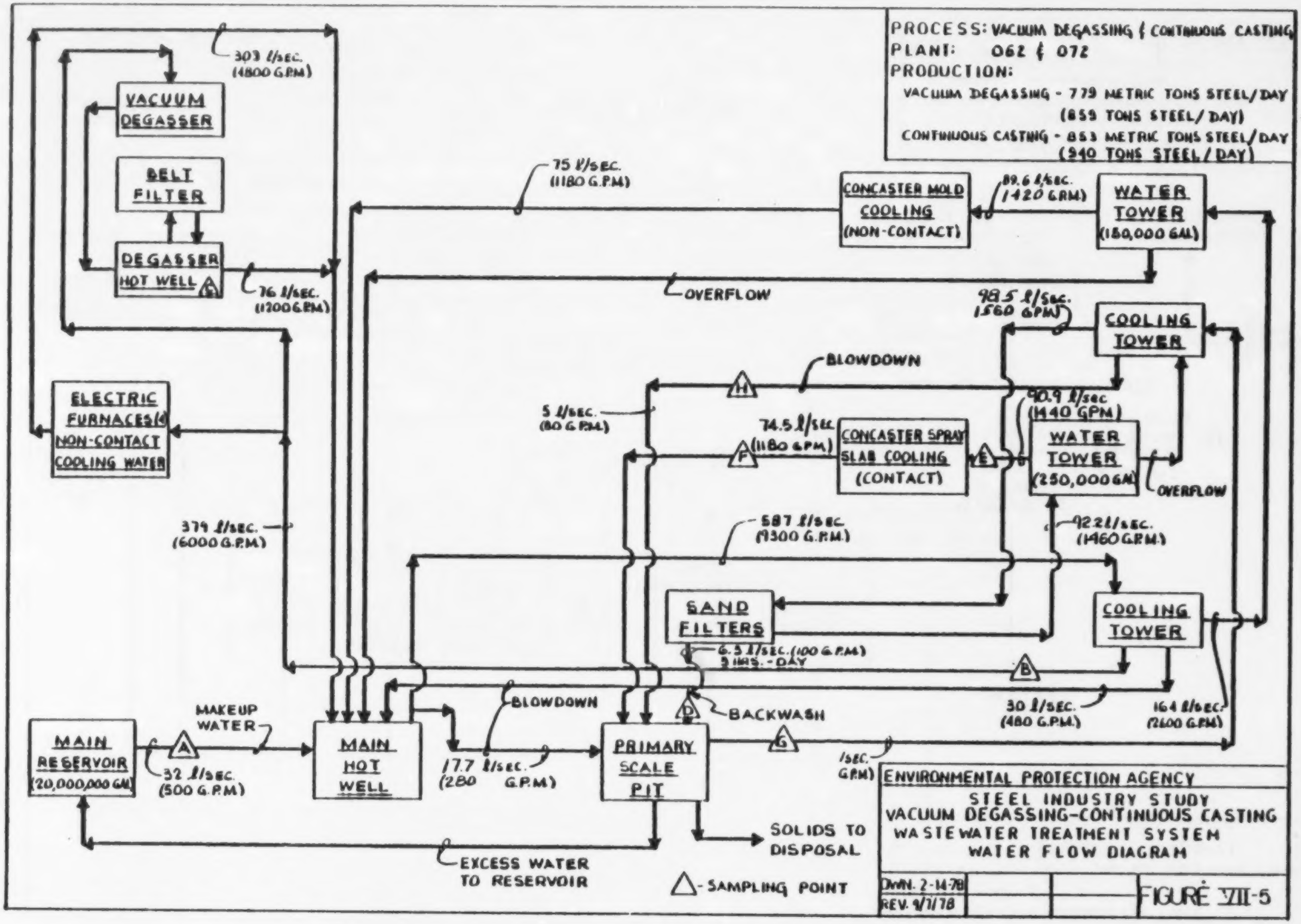
* INSTANTANEOUS FLOW RATES ALL OTHER FLOWS BASED UPON A 24 HOUR DAY.

△ SAMPLING POINTS

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
CONTINUOUS CASTING
WASTE WATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

DRN 12-5-77
REV. 9/18/78

FIGURE VII-4

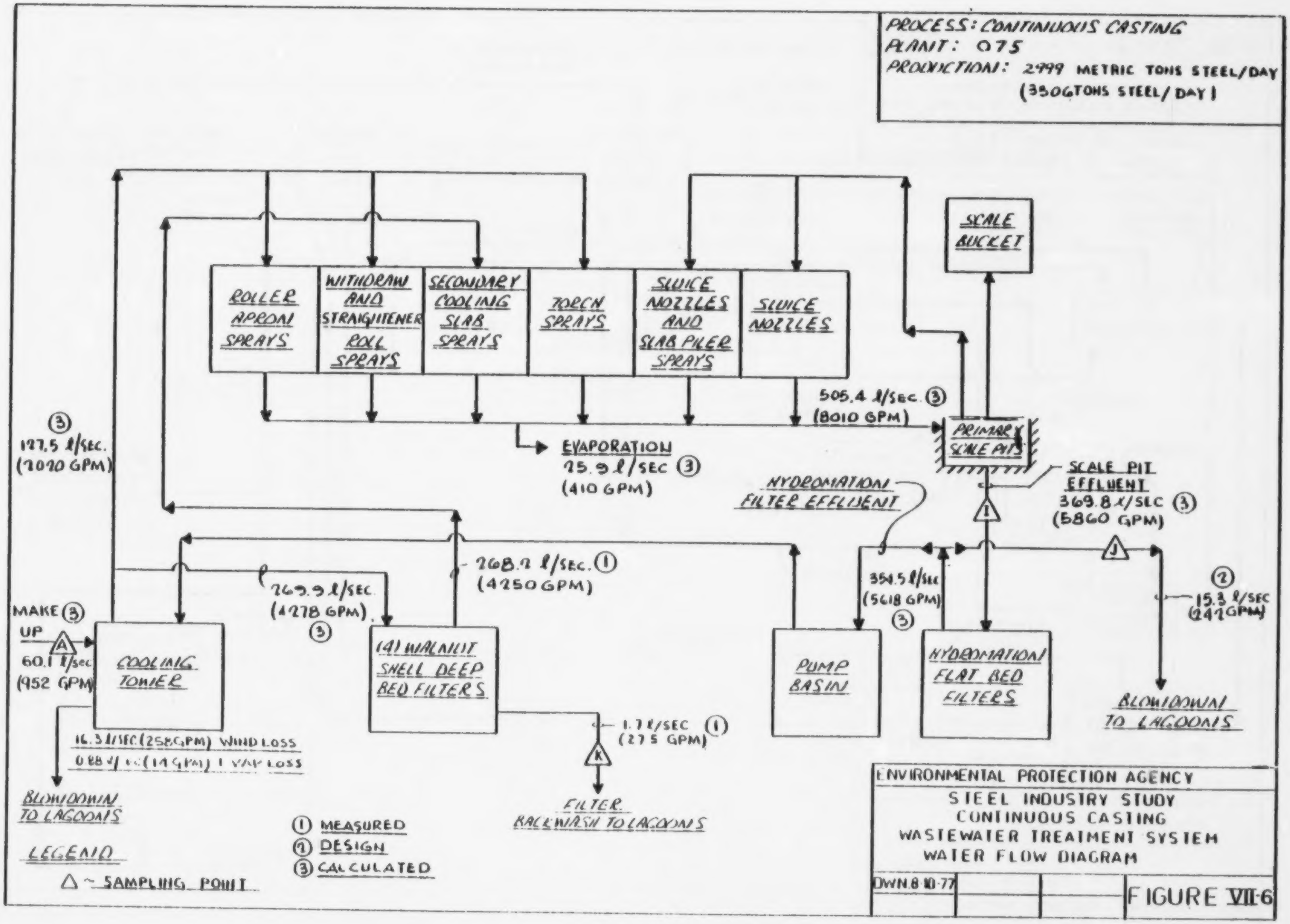

303 ℓ/SEC.
(4800 G.P.M.)
VACUUM DEGASSER
BELT FILTER
DEGASSER HOT WELL
C
76 ℓ/SEC.
(1200 G.P.M.)
75 ℓ/SEC.
(1180 G.P.M.)
CONCASTER MOLD COOLING (NON-CONTACT)
89.6 ℓ/SEC.
1420 G.P.M.)
WATER TOWER (180,000 GAL)
OVERFLOW
98.5 ℓ/SEC.
1560 GPM)
COOLING TOWER
BLOWDOWN
H
5 ℓ/SEC.
(80 G.P.M.)
90.9 ℓ/SEC
(1440 GPM)
74.5 ℓ/SEC
(1180 GPM)
F
CONCASTER SPRAY SLAB COOLING (CONTACT)
E
WATER TOWER (250,000 GAL)
OVERFLOW
ELECTRIC FURNACES & NON-CONTACT COOLING WATER
379 ℓ/SEC.
(6000 G.P.M.)
587 ℓ/SEC.
(9300 G.P.M.)
92.2 ℓ/SEC.
(1460 G.P.M.)
SAND FILTERS
COOLING TOWER
6.3 ℓ/SEC. (100 G.P.M.)
3 HRS. - DAY
B
30 ℓ/SEC.
(480 G.P.M.)
164 ℓ/SEC.
(2600 G.P.M.)
MAIN RESERVOIR (20,000,000 GAL)
A
32 ℓ/SEC.
(500 G.P.M.)
MAKEUP WATER
MAIN HOT WELL
BLOWDOWN
17.7 ℓ/SEC.
(280 G.P.M.)
D
BACKWASH
PRIMARY SCALE PIT
G
1 ℓ/SEC.
G.P.M.)
SOLIDS TO DISPOSAL
EXCESS WATER TO RESERVOIR
△-SAMPLING POINT

PROCESS: VACUUM DEGASSING & CONTINUOUS CASTING
PLANT: 062 & 072
PRODUCTION:
VACUUM DEGASSING - 779 METRIC TONS STEEL/DAY
(859 TONS STEEL/DAY)
CONTINUOUS CASTING - 853 METRIC TONS STEEL/DAY
(940 TONS STEEL/DAY)

ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
VACUUM DEGASSING-CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

DWN. 2-14-78
REV. 9/7/78

FIGURE VIII-5

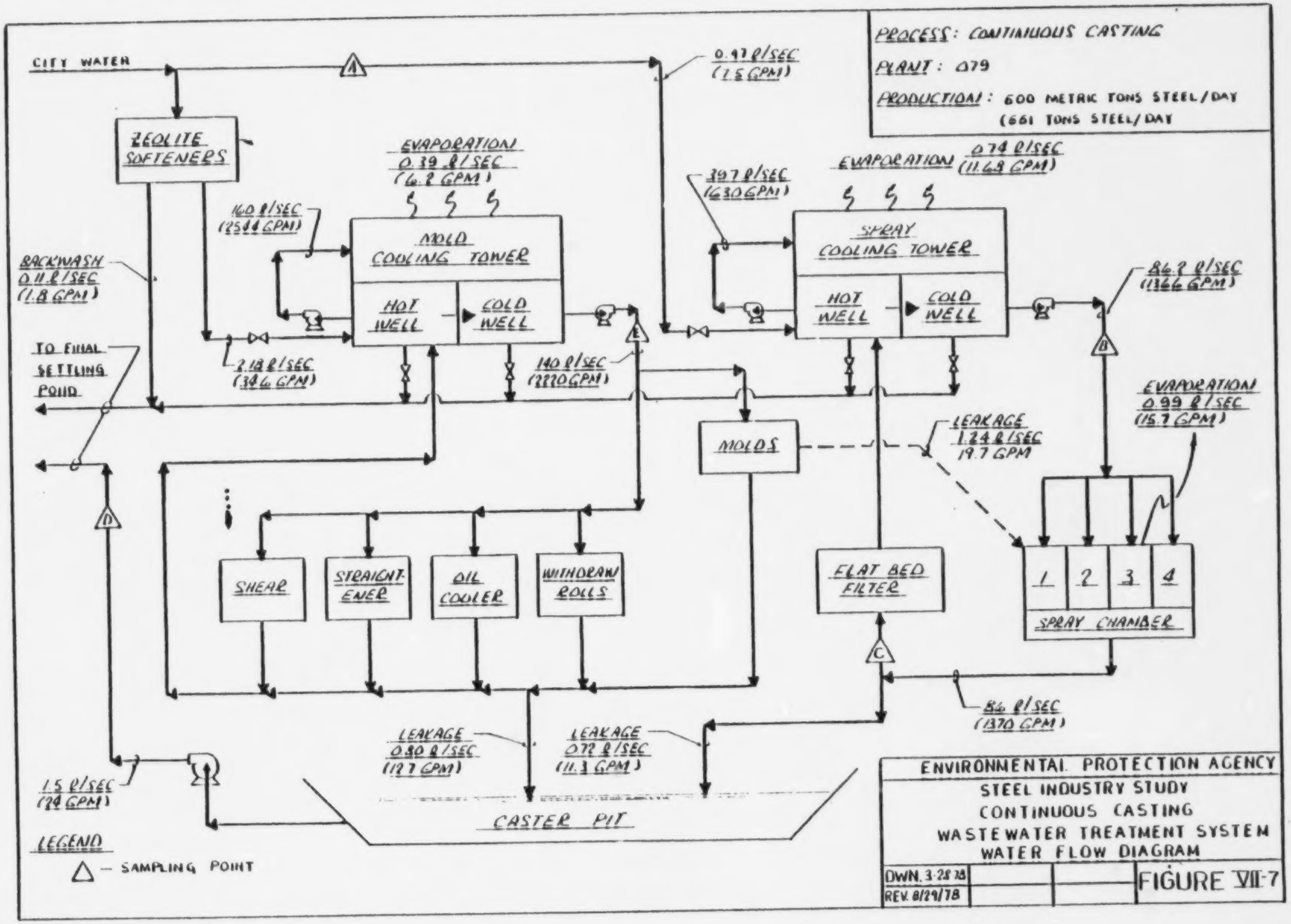

PROCESS: CONTINUOUS CASTING
PLANT: 075
PRODUCTION: 2999 METRIC TONS STEEL/DAY
(3306 TONS STEEL/DAY)
ROLLER APRON SPRAYS
WITHDRAW AND STRAIGHTENER ROLL SPRAYS
SECONDARY COOLING SLAB SPRAYS
TORCH SPRAYS
SLUICE NOZZLES AND SLAB PILER SPRAYS
SLUICE NOZZLES
SCALE BUCKET
505.4 l/SEC. ③
(8010 GPM)
PRIMARY SCALE PITS
③
127.5 l/SEC.
(2020 GPM)
EVAPORATION
25.9 l/SEC ③
(410 GPM)
HYDROMATION FILTER EFFLUENT
SCALE PIT EFFLUENT
369.8 l/SEC ③
(5860 GPM)
I
J
268.2 l/SEC. ①
(4250 GPM)
269.9 l/SEC.
(4278 GPM)
③
354.5 l/SEC
(5618 GPM)
③
②
15.3 l/SEC
(242 GPM)
MAKE ③
UP
A
60.1 l/sec
(952 GPM)
COOLING TOWER
(4) WALNUT SHELL DEEP BED FILTERS
PUMP BASIN
HYDROMATION FLAT BED FILTERS
BLOWDOWN TO LAGOONS
1.7 l/SEC ①
(27.5 GPM)
K
FILTER BACKWASH TO LAGOONS
16.3 l/SEC (258 GPM) WIND LOSS
0.88 l/SEC (14 GPM) EVAP LOSS
BLOWDOWN TO LAGOONS
LEGEND
△ ~ SAMPLING POINT
① MEASURED
② DESIGN
③ CALCULATED

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

DWN 8-10-77

FIGURE VII-6


PROCESS: CONTINUOUS CASTING
PLANT: 079
PRODUCTION: 600 METRIC TONS STEEL/DAY
(661 TONS STEEL/DAY
CITY WATER
A
0.47 l/SEC
(7.5 GPM)
ZEOLITE SOFTENERS
EVAPORATION
0.39 l/SEC
(6.2 GPM)
160 l/SEC
(2544 GPM)
MOLD COOLING TOWER
HOT WELL
COLD WELL
BACKWASH
0.11 l/SEC
(1.8 GPM)
2.18 l/SEC
(34.6 GPM)
E
140 l/SEC
(2220 GPM)
TO FINAL SETTLING POND
EVAPORATION 0.74 l/SEC
(11.68 GPM)
39.7 l/SEC
(630 GPM)
SPRAY COOLING TOWER
HOT WELL
COLD WELL
86.2 l/SEC
(1366 GPM)
B
EVAPORATION
0.99 l/SEC
(15.7 GPM)
MOLDS
LEAKAGE
1.24 l/SEC
19.7 GPM
D
SHEAR
STRAIGHTENER
OIL COOLER
WITHDRAW ROLLS
FLAT BED FILTER
1
2
3
4
SPRAY CHAMBER
C
86 l/SEC
(1370 GPM)
LEAKAGE
0.80 l/SEC
(12.7 GPM)
LEAKAGE
0.72 l/SEC
(11.3 GPM)
1.5 l/SEC
(24 GPM)
CASTER PIT
LEGEND
△ - SAMPLING POINT
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
CONTINUOUS CASTING
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
DWN. 3-28-78
REV. 8/29/78
FIGURE VII-7

CONTINUOUS CASTING SUBCATEGORY

SECTION VIII

COST, ENERGY, AND NONWATER QUALITY IMPACTS

Introduction

This section addresses the cost, energy, and nonwater quality impacts of applying the different levels of pollution control to continuous casting plants. It includes a discussion of actual treatment costs incurred by plants sampled, the alternative treatment technologies considered for use in the casting subcategory, and the cost, energy, and other nonwater quality impacts associated with the application of the BPT, BAT, BCT, NSPS, PSES, and PSNS alternative treatment systems. In addition, the BCT cost comparison and the consumptive use of water are addressed.

Actual Costs Incurred by Plants Sampled For This Study

The water pollution control costs for the continuous casters visited during this study are presented in Table VIII-I. The costs were derived from data supplied by the industry at the time of sampling or from data submitted in response to the D-DCPs. The costs have been adjusted to July 1978 dollars. In some instances, standard cost of capital and depreciation factors were applied to the reported costs to determine those portions of the annual costs of operation. In the remaining instances, those costs were provided by the plants.

The capital cost data from the plants noted above were compared with the Agency's estimated expenditures, factored on the basis of tonnage (TPD) for these plants. This comparison is difficult, because many component costs may vary due to the fact that different plant personnel use different methods to determine costs. Despite these limitations, the comparison which follows indicates that model cost estimates of seven continuous casting operations are representative of the actual costs of these operations.

CONTINUOUS CASTING
EFFLUENT TREATMENT COST COMPARISON

Plant	Actual Cost	Estimated(1) Cost
0584 F	2,413,632	4,401,000
0868 B	3,559,140	2,338,000
0384 A(2)	2,028,858	2,274,000
0384 A(3)	10,025,762	4,397,000
0528 A	5,926,290	5,828,000
0620 A	1,030,000	1,084,000
0684 E	4,397,468	2,682,000
Total Cost	29,381,150	23,004,000

(1) Estimates are made on a tonnage (TPD) basis.
(2) Billet casting operation.
(3) Slab casting operation.

Reference can be made to the cost estimates discussion presented in Volume 1 for further verification of the applicability of the treatment model costs.

The data show that industry costs are about 28% higher than the Agency's estimate for the seven continuous casting treatment systems. However, most of the difference is attributed to the continuous slab caster at Plant 0384 A, which has an applied flow which is twice that of the model flow. EPA estimates are based upon production and not upon applied flow. Thus, the treatment components in place at this facility are larger than the corresponding model size treatment components, which are more typical of the subcategory. Industry costs would be about 4 percent higher than the Agency's estimates when this facility is not included in the comparison. In any event, the above data demonstrate reasonably good agreement between actual industry costs and EPA estimates. The Agency concludes that its cost estimates for the continuous casting subcategory accurately reflect actual costs.

Control and Treatment Technologies (C&TT)
Recommended For Use in Continuous Casting

The BPT and BAT model treatment system components are presented in Table VIII-2. It should be noted that these specific C&TT components are not required. Any treatment system which achieves compliance with the proposed effluent limitations is adequate.

On this summary table, the following items are described for each step:

1. Treatment and/or control methods employed
2. Status and reliability
3. Problems and limitations
4. Implementation time
5. Land requirements

6. Environmental impacts other than water
7. Solid waste generation and primary constituents

Cost, Energy, and Nonwater Quality Impacts

Estimated Costs for the Installation of Pollution Control Technologies

A. Costs Required to Achieve the Proposed BPT Limitations

In order to develop BPT compliance costs, it was necessary to develop a BPT model sized to represent the average continuous casting plant found in the United States. The model size (ton/day) was developed on the basis of the average production capacity of all continuous casters. The treatment model components and flow rates are also representative of actual continuous casting operations. The unit cost for each treatment model component was developed. These costs are presented in Table VIII-3 along with BPT model annual costs and raw and effluent flows and concentrations.

The capital requirements needed to achieve the BPT level of treatment for the continuous casting subcategory were determined by applying the treatment component model costs, adjusted for size, to each casting operation. The estimates of the expenditures required to bring these plants from current treatment levels to the proposed BPT limitations, were necessary to assess the economic impact of the various effluent limitations upon the industry. These tabulations are presented in Table VIII-4. The estimated capital costs of BPT technology in this subcategory are $102.6 million (July 1978 dollars). Of this total, equipment valued at $60.7 million is currently in place in various casting facilities as of January 1978. The remaining $41.9 million remains to be expended for additional treatment equipment. The estimated annual operating costs for BPT treatment in this subcategory are approximately $24 million.

B. Cost Required to Achieve the Proposed BAT Limitations

The Agency considered two alternative treatment systems for the BAT model treatment system as described in Section X. The investment and annual expenditures for each of the BAT alternative treatment systems, in excess of BPT expenditures, are presented in Table VIII-5. The subcategory investment and annual expenditures for each BAT alternative are shown below.

BAT Alternative	Investment Cost	Annual Cost
No.1	$4,350,000	$ 780,000
No.2	$5,450,000	$1,000,000

C. Costs Required to Achieve the Proposed BCT Limitations

The BCT cost analysis is presented in Table VIII-6, while additional information regarding BCT is provided in Section XI.

Since the BCT technology is the same as the BAT-1 alternative, reference is made to the BAT-1 costs.

D. Costs Required to Achieve the Proposed NSPS

The Agency considered two treatment alternatives for continuous casting facilities which are constructed after the proposal of these standards. The NSPS treatment models are similar to the BPT/BAT model treatment systems. The NSPS treatment alternatives are discussed in Section XII, while the NSPS treatment model costs are presented in Table VIII- 7.

E. Costs Required to Achieve the Proposed Pretreatment Standards

Pretreatment standards apply to those existing (PSES) and new (PSNS) sources which continue or elect to discharge to POTW systems. The two pretreatment systems considered by the Agency are identical to the two NSPS alternatives. Table VIII-7 presents the costs associated with these alternatives, while additional information is presented in Section XIII.

Energy Impacts

Moderate amounts of energy will be required by the various levels of treatment in the continuous casting subcategory. The major energy expenditures for the subcategory occur at the BPT treatment level, while other treatment levels require rather minor incremental energy expenditures.

A. Energy Impacts at BPT

The estimated energy requirements are based upon the assumptions that treatment systems similar to the model treatment system will be installed at all continuous casting shops, and, that these systems will have flows similar to those of the model. On this basis, the estimated annual energy usage for BPT treatment components for all continuous casting operations is 129.2 million kilowatt-hours of electricity. This estimate represents about 0.23 percent of the 57 billion kilowatt-hours used by the steel industry in 1978.

B. Energy Impacts at BAT

The estimated energy requirements for the BAT alternative treatment systems are based upon the same assumptions noted above for BPT. The estimated energy requirements needed to upgrade facilities from BPT to the two BAT alternatives follow.

BAT Alternative	kwh per year	% of 1978 Industry Usage
No.1	400,000	0.0007
No.2	800,000	0.0014

C. Energy Impacts at BCT

As the BCT treatment model is the same as the BAT-1 model, the energy requirements at BCT are identical to the BAT-1 requirements.

D. Energy Impacts at NSPS, PSES, and PSNS

The energy requirements for the NSPS, PSES, and PSNS models follow. The Agency did not evaluate the total energy requirements for NSPS and PSNS since estimates of future additions were not made as part of this study.

Model	kwh per year
NSPS-1,PSES/PSNS-1	2,588,000
NSPS-2,PSES/PSNS-2	2,604,000

Nonwater Quality Impacts

In general, the nonwater quality impacts associated with the alternative treatment technologies are minimal. The three impacts evaluated are air pollution, solid waste disposal, and water consumption.

A. Air Pollution

Sulfide addition is incorporated in the model treatment systems of BAT, NSPS, PSES, and PSNS Alternatives No. 2. In the event of treatment process control upsets, the atmospheric discharge of sulfides could occur. However, as continuous casting wastewaters are not typically acidic, the possibility of atmospheric discharges is minimized. The Agency did not select this alternative as the model treatment system for BAT, NSPS, PSES, and PSNS. The Agency expects no adverse air pollution impacts associated with any of the selected model treatment systems.

B. Solid Waste Disposal

The treatment steps incorporated in the BPT and BAT treatment systems will generate significant quantities of solids and oils and greases. A summary of the solid waste generation, on a dry basis, for the continuous casting subcategory, at the BPT, BAT, and BCT levels of treatment, follows.

Treatment Level	Solid Waste Generation Continuous Casting Subcategory (Tons/Year)
BPT	7,245
BAT-1,BCT	120
BAT-2	120

As just shown, significant amounts of solid wastes are generated by the BPT model treatment system, while the BAT and BCT alternative treatment systems generate relatively minor additional amounts of solid wastes. Most of the solid waste is comprised of suspended solids (principally iron oxides) which require proper disposal, if they are not reused in the iron and steel making operations. The oils, which can not be reused or reclaimed, also require proper disposal, generally off-site.

The estimated amounts of solid wastes and oils and greases generated by the NSPS and Pretreatment models follow.

Treatment Level	Solid Waste Generation Treatment Model (Tons/Year)
NSPS-1, PSES/PSNS-1	471
NSPS-2, PSES/PSNS-2	471

C. Water Consumption

The Agency analyzed the consumption of water by the alternative treatment systems. In July of 1978, the continuous casting industry consumed 3.55 million gallons of water per day (MGD). This water evaporated from treatment components and from large bodies of water (i.e., reservoirs, rivers). Upon installation of the BPT model or BAT alternative treatment systems, this total will increase slightly to 4 MGD. Based on the model raw wastewater flow of 3400 gal/ton, the total subcategory usage is about 238 MGD. Therefore, the fraction of water actually consumed is very small, about 1.7%. This slight increase in the amount of water consumed is rather insignificant when compared to the remaining water that will be recycled. The volume of fresh water required for use as make-up will be greatly reduced due to recycle, and very little additional fresh water will become contaminated.

The Agency concluded that the pollution control benefits associated with recycle, in this subcategory, justify the above minor water losses on both a nation-wide and an arid or semi-arid region basis. Three of the four plants the Agency considers to be in arid or semi-arid regions have recycle systems installed for continuous casting operations. Hence, the effect of the proposed limitations on additional water losses for these plants will be negligible. The fourth plant does not have a continuous casting operation. If one were installed at this facility, only about 0.3 MGD would be lost. The Agency concludes that losses of this magnitude at this site are not significant.

Summary of Impacts

In summary, the Agency concludes that the pollutant reduction benefits described below in tons/year, for the continuous casting subcategory outweigh any adverse energy and nonwater quality environmental impacts.

	Raw Waste	Proposed BPT	Proposed BAT and BCT
Flow, MGD	238	8.8	1.8
TSS	21,735	666	40
Oil and Grease	9,060	200	13
Toxic Metals	590	22	1.3
Toxic Organics	17	3.3	0.7

TABLE VIII-1

EFFLUENT TREATMENT COSTS
CONTINUOUS CASTING

(All costs expressed in July, 1978 dollars)

Plant Code	AE(1)	AF	071	–
Reference Code	0584F	0868B	0284A	0384A(5)
Initial Investment ($)	2,413,632	3,559,140	–	2,028,858
Annual Costs ($)				
Cost of Capital	103,786(2)	153,043(2)	–	87,241(2)
Depreciation	241,363(3)	355,914(3)	–	202,886(3)
Oper. & Maint.	176,936	993,429	49,234	201,390
Energy & Power	Included Above	Included Above	66,847	132,136
Chemical Costs	–	–	–	–
Other (sludge, etc.)	–	–	–	50,985
TOTAL ($)	522,085	1,502,386	116,081	674,638
$/Ton	0.40(4)	2.95(4)	1.07(4)	1.11(4)

TABLE VIII-1
EFFLUENT TREATMENT COSTS
CONTINUOUS CASTING
PAGE 2

(All costs expressed in July, 1978 dollars)

Plant Code	0528A	0620A	0684E
Reference Code	-	-	-
Initial Investment ($)	5,926,290	1,030,000	4,397,468
Annual Costs ($)			
Cost of Capital	266,683(2)	44,290(2)	197,886(2)
Depreciation	592,629(3)	85,000(6)	439,747(3)
Oper. & Maint.	-	50,000	-
Energy & Power	-	80,000	-
Chemical Costs	-	-	-
Other (sludge, etc.)	-	6,000	-
TOTAL ($)		265,290	
$/Ton	-	0.84(4)	-

---

(1) Resampled as Plant 075.
(2) Cost of capital was calculated by using the following formula: (0.043) x (initial investment).
(3) Depreciation was calculated by using the following formula: (0.10) x (initial investment).
(4) Calculation based on 1976 production.
(5) Billet caster.
(6) Depreciation based upon a 12 year life.

TABLE VIII-2

CONTROL AND TREATMENT TECHNOLOGIES
CONTINUOUS CASTING SUBCATEGORY

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
A. Scale Pit with Drag Link Conveyor - initial solid waste reduction accomplished via gravity sedimentation, drag link conveyor removes solids from pit	Very reliable, widely used in this and other subcategories	Accumulated solids must be periodically removed	6-8 months	20' x 35'	Accumulated solids must be disposed of properly	See Step C
B. Surface Skimming - initial surface oil reduction accomplished via skimming	Widely used in this and other subcategories	Hydraulic overload or surface turbulence will reduce effectiveness	3 months	-	Skimmed oils and greases must be disposed of properly	Generation of oils and greases.
C. Flat Bed Filter - additional solid waste reduction accomplished via filtration	Widely used in this subcategory	Proper speed must be maintained to assure maximum efficiency	15-18 months	2400 ft^2	Accumulated solids must be disposed of properly	Generation of solid wastes in scale pit and flat bed filter.
D. Recycle Pump Well and Pump System - recycle large portion of treated flow back to caster	Widely used in this and other subcategories	Potential for scaling, plugging, or fouling of recycle system, pumps require maintenance	12-14 months	20' x 30'	None	None
E. Cooling Tower - heat load of wastewaters reduced	Widely used in this and other subcategories	Potential for scaling or plugging due to accumulation of dissolved solids	18-20 months	30' x 30'	Any sludge accumulation in the cooling tower will require removal	Minimal

TABLE VIII-2
CONTROL AND TREATMENT TECHNOLOGIES
CONTINUOUS CASTING SUBCATEGORY
PAGE 2

Treatment and/or Control Methods Employed	Status and Reliability	Problems and Limitations	Implementation Time	Land Requirements	Environmental Impact Other Than Water	Solid Waste Generation and Primary Constituents
F. Filter - additional solid waste and oil and grease reduction accomplished	Widely used in this and other subcategories	Surges must be controlled	15-18 months	20' x 20'	Accumulated solids must be disposed of properly	Generation of oils and greases. Generation of solid wastes.
G. Sulfide Precipitation - metallic sulfide precipitates form due to sulfide which has been added	Practiced in similar metal manufacturing industries for toxic metals removal	Requires careful handling and stringent odor control	6 months	10' x 10'	Requires proper sludge disposal and odor control	Metal sulfide precipitates are generated.

TABLE VIII-3

BPT MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory: Continuous Casting
: Carbon/Specialty

Model Size-TPD : 1400
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	A	B	C	D	Total
Investment $ x 10^{-3}	320	543	891	550	2304
Annual Cost $ x 10^{-3}					
Capital	13.7	23.3	38.3	23.7	99.0
Depreciation	32.0	54.3	89.1	55.0	230.4
Operation and Maintenance	11.2	19.0	31.2	19.3	80.7
Sludge Disposal	1.4	0.5	-	-	1.9
Energy and Power (1)	-	19.8	44.9	24.5 (2)	64.7
Oil Disposal	-	1.4	-	-	1.4
TOTAL	58.3	118.3	203.5	98.0 (2)	478.1

	Effluent Quality (3)	Raw Waste Level	BPT Effluent Level
	Flow, gal/ton	3400	125
	Total Suspended Solids	60	50
	Oil and Grease	25	15
	pH, Units	6-9	6-9
119	Chromium	0.65	0.65
120	Copper	0.11	0.11
122	Lead	0.090	0.090
125	Selenium	0.080	0.080
128	Zinc	0.70	0.70

---

(1) Costs are all power unless otherwise noted.
(2) Total does not include power cost, as a credit is supplied for existing process water requirements.
(3) All values are in mg/l unless otherwise noted.

KEY TO C&TT STEPS

A: Scale Pit, Drag Link Conveyor, and Oil Skimming Device
B: Flatbed Filter
C: Cooling Tower
D: Recycle

TABLE VIII-4

BPT CAPITAL COST TABULATION
BASIS: 7/1/78 DOLLARS x 10^{-3}
FACILITIES IN PLACE AS OF 1/1/78
CONTINUOUS CASTING

		C&TT Step						
Plant Code	TPD	A	B	C	D	In Place	Required	Total
0060	3800	583	-	1622	1001	3206	0	3206
0060D	1000	262	444	728	449	1883	0	1883
0060H	1200	292	495	812	501	1605	495	2100
0060K	655	203	344	565	349	1461	0	1461
0068B	880	242	-	-	416	658	0	658
0076	700	211	-	-	363	574	0	574
0084A	750	220	-	612	378	1210	0	1210
0112D	4100	610	1035	1698	1048	1048	3343	4391
0132	540	181	307	503	310	0	1301	1301
0136B	576	188	319	523	323	0	1353	1353
0180	400	151	256	420	259	410	676	1086
0188C	1200	292	495	812	501	0	2100	2100
0204	1000	262	444	728	449	0	1883	1883
0248B	1100	277	470	-	476	1223	0	1223
0284A	550	183	310	509	314	1316	0	1316
0316	850	237	403	660	408	0	1708	1708
0316A(1)	900	245	417	684	422	0	1768	1768
0384A(2)	1370	316	536	879	543	2274	0	2274
0384A	4110	611	1036	1700	1050	4397	0	4397
0432A	1500	334	566	929	573	907	1495	2402
0444	500	173	293	480	297	763	480	1243
0456A	600	192	327	536	331	0	1386	1386
0460A	950	254	430	706	436	1396	430	1826
0468B	1600	347	588	965	596	2496	0	2496
0468F	3450	550	933	1531	945	3026	933	3959
0476A	533(3)	179	304	499	308	308	982	1190
0496	1600	347	588	965	596	2496	0	2496

TABLE VIII-4
BPT CAPITAL COST TABULATION
BASIS: 7/1/78 DOLLARS x 10^{-3}
FACILITIES IN PLACE AS OF 1/1/78
CONTINUOUS CASTING
PAGE 2

Plant Code	TPD	C&TT Step A	B	C	D	In Place	Required	Total
0528A	6575	809	1374	2254	1391	5828	0	5828
0548D	600	192	327	536	331	523	863	1386
0584F	4118	611	1037	1702	1051	4401	0	4401
0596	800	-	388	-	393	781	0	781
0608A	600	192	327	536	331	523	863	1386
0620A	900	245	417	-	422	1084	-	1084
0620B	800	229	388	637	393	622	1025	1647
0620C	1200	292	495	812	501	0	2100	2100
0652	1440	325	552	906	559	325	2017	2342
0672A	1152	285	-	793	489	1567	0	1567
0672B	700	211	358	588	363	0	1520	1520
0684E	1804	373	632	1037	640	2050	632	2682
0696A	960	255	433	710	439	1404	433	1837
0740A	380	146	248	407	252	659	394	1053
0764	720	215	364	598	369	0	1546	1546
0780	1200	292	-	812	501	1605	0	1605
0796A	900	245	417	683	422	0	1767	1767
0856F	1500	334	566	929	573	334	2068	2402
0860B	4156	615	1043	1712	1057	615	3812	4427
0860H	2542	458	-	1274	787	2519	0	2519
0864C	820	232	394	646	399	878	793	1671
0868B	1435	325	551	904	558	2338	0	2338
0946A	870	241	408	670	413	0	1732	1732
						60,713	41,898	102,611

---

(1) Billet caster.
(2) Slab caster.
(3) This figure represents 1976 production rather than rated capacity.

KEY TO C&TT STEPS

A: Primary Scale Pit, Drag Link Conveyor, and Oil Skimming Device
B: Flatbed Filter
C: Cooling Tower
D: Recycle

TABLE VIII-5

ALTERNATIVE BAT MODEL COSTS: BASIS 7/1/78 DOLLARS

Subcategory:	Continuous Casting	Model Size-TPD :	1400
:	Carbon/Specialty	Oper. Days/Year:	365
		Turns/Day :	3

	Alternative 1		Alternative 2		
C&TT Step	E	Total	F	E	Total
Investment \$ x 10^{-3}	87	87	22	87	109
Annual Cost \$ x 10^{-3}					
Capital	3.7	3.7	1.0	3.7	4.7
Depreciation	8.7	8.7	2.2	8.7	10.9
Operation & Maintenance	3.0	3.0	0.8	3.0	3.8
Energy & Power(1)	0.2	0.2	0.2	0.2	0.4
Chemical Costs	-	-	0.2	-	0.2
TOTAL	15.6	15.6	4.4	15.6	20.0

	Effluent Quality(2)	BAT Feed Level	BAT No.1 Effluent Level	BAT No.2 Effluent Level
	Flow, gal/ton	25	25	25
	Total Suspended Solids	50	15	15
	Oil & Grease	15	5	5
	pH, Units	6-9	6-9	6-9
119	Chromium	0.65	0.10	0.10
120	Copper	0.11	0.10	0.10
122	Lead	0.090	0.090	0.090
125	Selenium	0.080	0.080	0.080
128	Zinc	0.70	0.10	0.10

---

(1) Costs are all power unless otherwise noted.
(2) All values are in mg/l unless otherwise noted.

KEY TO C&TT STEPS

E: Filtration
F: Sulfide Addition

TABLE VIII-6

RESULTS OF BCT COST TEST
CONTINUOUS CASTING SUBCATEGORY

A. BCT Feed

Effluent concentration of conventional pollutants = 65 mg/l
Flow = 0.175 MGD
Days/Year = 365
lbs/year of conventional pollutants discharged = 34,627

B. BCT

Effluent concentration of conventional pollutants = 20 mg/l
Flow = 0.035 MGD
Days/Year = 365
lbs/year of conventional pollutants discharged = 2131

lbs/year of conventional pollutants removed via BCT treatment
(BCT Feed - BCT) = 34,627- 2131 = 32,496

Annual cost of BCT* = 15,600 $/lb = 0.48 PASS

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* Includes all C&TT Steps.

TABLE VIII-7

NSPS, PSES, AND PSNS MODEL COST DATA: BASIS 7/1/78 DOLLARS

Subcategory: Continuous Casting
: Carbon/Specialty

Model Size-TPD : 1400
Oper. Days/Year: 365
Turns/Day : 3

C&TT Step	Alternative 1					Alternative 2 (Alternative 1 plus E&F)		
	A	B	C	D	Total	E	F	Total (incl.A-F)
Investment $ x 10^{-3}	320	543	891	550	2304	22	87	2413
Annual Cost $ x 10^{-3}								
Capital	13.7	23.3	38.3	23.7	99.0	1.0	3.7	103.7
Depreciation	32.0	54.3	89.1	55.0	230.4	2.2	8.7	241.3
Operation & Maintenance	11.2	19.0	31.2	19.3	80.7	0.8	3.0	84.5
Sludge Disposal	1.4	0.5	-	-	1.9	-	-	1.9
Energy & Power (1)	-	19.8	44.9	24.5 (2)	64.7	0.2	0.2	65.1
Oil Disposal	-	1.4	-	-	1.4	-	-	1.4
Chemical Costs	-	-	-	-	-	0.2	-	0.2
TOTAL	58.3	118.3	203.5	98.0	478.1	4.4	15.6	498.1

Effluent Quality (3)	NSPS & PSES/PSNS Feed Level	NSPS & PSES/PSNS No.1 Effluent Level	NSPS & PSES/PSNS No.2 Effluent Level
Flow, gal/ton	3400	25	25
Total Suspended Solids	60	15	15
Oil & Grease	25	5	5
pH, Units	6-9	6-9	6-9
119 Chromium	0.65	0.10	0.10
120 Copper	0.11	0.10	0.10
122 Lead	0.090	0.090	0.090
125 Selenium	0.080	0.080	0.080
128 Zinc	0.70	0.10	0.10

---

(1) Costs are all power unless otherwise noted.
(2) Total cost does not include power, because a credit is supplied for existing process water requirements.
(3) All values are in mg/l unless otherwise noted.

KEY TO C&TT STEPS

A: Scale Pit with Drag Link Conveyor and Oil Skimming Device
B: Flat Bed Filter
C: Cooling Tower
D: Recycle
E: Sulfide Precipitation
F: Filtration

CONTINUOUS CASTING SUBCATEGORY

SECTION IX

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

Introduction

The Agency is proposing BPT limitations which are the same as those orginally promulgated in 1974.[1] A review of the treatment processes and effluent limitations associated with the continuous casting subcategory follows.

Identification of BPT

The BPT model treatment system is the same as the system used to develop the original BPT limitations promulgated in June 1974. This system includes a primary scale pit equipped with a drag link conveyor and oil removal facilities, a flat bed filter, a cooling tower, and recycle. Solids collected by the scale pit are disposed internally or landfilled. Accumulated oils are hauled away or incinerated. The overflow from the scale pit is pumped to a flat bed filter. The filter effluent is recycled through a cooling tower to the process, except for a small blowdown, which is discharged to a receiving stream. Make-up water is added to the recycle system to compensate for evaporative and blowdown losses.

Figure IX-1 depicts the BPT model treatment system for continuous casters. The proposed BPT effluent limitations, which represent 30-day average values, are presented below:

Pollutant	kg/kkg of Product (lb/1000 lb of Product)
Suspended Solids	0.026
Oil and Grease	0.0078
pH (Units)	6.0-9.0

The proposed maximum daily effluent limitations are three times the monthly average value.

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[1] See EPA 440/1-74 024a; Development Document for Effluent Limitation Guidelines and New Source Performance Standards for the Steelmaking Segment of the Iron and Steel Manufacturing Point Source Category, June 1974.

Rationale for BPT Treatment System

As noted in Section VII, each of the BPT model treatment system components is in use at a number of continuous casting operations.

Justification of BPT

Table IX-1 presents sampled plant effluent data which support the proposed BPT limitations. As only one of these plants employs flat bed filtration, the ability of continuous casting facilities to achieve the proposed BPT effluent limitations with other types of filtration is well demonstrated. One sampled plant was unable to achieve the proposed BPT limitations, because filter backwash water was discharged directly. Recycling the backwash for further treatment and increasing the total system recycle rate would allow that plant to meet the proposed limitations. Hence, based upon the data from those plants and those achieving zero discharge, the Agency concludes the proposed BPT limitations are achievable.

TABLE IX-1

EFFLUENT LOAD (lbs/1000 lbs) JUSTIFICATION
CONTINUOUS CASTING

	Discharge Flow (gal/ton)	Suspended Solids	Oil and Grease	pH	C&TT Components
Originally Promulgated BPT	125	0.026	0.0078	6.0-9.0	PSP,SS,FF,CT,RTP96.3
Plants					
AF (0868B)	17	0.0016	0.000035	6.8	PSP,SS,FDSP,CT,RTP98.9
D (0248B)	Zero Discharge			*	PSP,SSP,SS,FDSP,Scr, RTP100
Q (Unk)	Zero Discharge			8.9	PSP,CT,RTP100
071 (0284A)	Zero Discharge			9.4	PSP,FSP,T,CT,RTP100
072 (0496)	Zero Discharge			7.6-8.1	PSP,FLP,FDSP,CLA, CT,RTP100
079 (0060K)	25	0.0050	0.0041	7.1-7.2	PSP,FF,CT,RTP100

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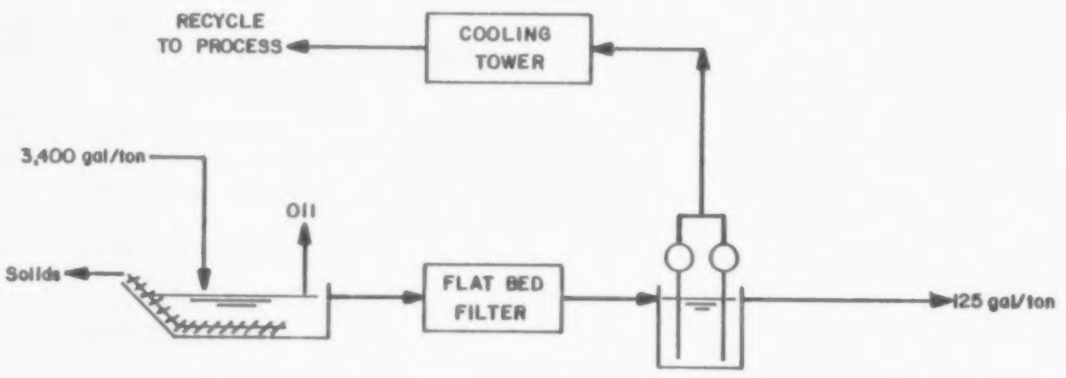
* Insufficient Data


RECYCLE TO PROCESS
COOLING TOWER
3,400 gal/ton
Oil
Solids
FLAT BED FILTER
125 gal/ton

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
CONTINUOUS CASTING SUBCATEGORY
BPT MODEL

Dwn. 6/11/80

FIGURE IX-1

CONTINUOUS CASTING SUBCATEGORY

SECTION X

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Introduction

The Best Available Technology Economically Achievable (BAT) effluent limitations are to be achieved by July 1, 1984. BAT is determined by reviewing subcategory practices and identifying the best economically achievable control and treatment technologies employed within a subcategory. In addition, a technology that is readily transferable from another subcategory or industry may be identified as BAT.

This section identifies the model BAT flow rate, the two BAT alternative treatment systems, and the resulting effluent levels considered for the continuous casting subcategory. The rationale for selecting the treatment technologies is also presented. Finally, this section addresses the Agency's selection of a BAT model treatment system to serve as the basis for the proposed BAT limitations.

BAT Flow Rate

Reanalysis of the available data has shown that the BPT discharge flow of 125 gal/ton is much higher than the actual average discharge flow demonstrated by the plants employing technology similar to the model treatment technologies (i.e., primary scale pit with drag link conveyor and surface skimming, flat bed filter, recycle, and cooling towers). While the Agency is retaining a model BPT flow which is less stringent than might be justified, it has set the model BAT flow at 25 gal/ton. Plants having BPT recycle systems installed, and currently not achieving this flow, can increase the recycle rate at little or no cost to achieve 25 gal/ton. Plant responses indicated that fouling and scaling are not problems in this subcategory.

Identification of BAT

Based upon information contained in Sections III through VIII, the Agency developed the following BAT alternative treatment systems (as add-ons to the BPT model treatment system) for the continuous casting subcategory.

A. BAT Alternative No.1

In the first BAT Alternative, the blowdown from the BPT system is filtered. As the metals in the blowdown are in particulate form, filtration is effective in removing those metals entrained in suspended solids.

B. BAT Alternative No.2

In this alternative, a sulfide precipitation step is included prior to the filtration step outlined above. Sulfide precipitation techniques are capable of providing a higher degree of toxic metals removal. In this case, more zinc is removed.

Figure X-1 illustrates the two BAT alternative treatment systems described above for the continuous casting subcategory. The treatment systems include technologies in use at one or more plants, or demonstrated in other wastewater treatment applications.

The proposed BAT limitations are presented in Table X-1. The pollutants listed in this table represent a condensation of the list of selected pollutants presented in Section VI. The Agency selected pollutants for limitation based upon the following factors: treatability using the technologies presented in the alternatives; quantity and toxicity in relation to the other process wastewater pollutants; and, the ability to serve as indicators of both the presence and the removal of other pollutants.

Analytical data indicate that zinc is present at higher levels than any of the other toxic pollutants found in continuous casting wastewaters. As noted in Volume I, treatment of those toxic pollutants found at high levels in the process wastewaters will result in treatment of the toxic pollutants found at lower levels. Based upon the observations noted above, the Agency selected zinc as the toxic pollutant to be limited at BAT. While other toxic metals are found in continuous casting wastewaters, the control of zinc will also result in comparable controls of the other toxic metals. However, in order to make the continuous casting limitations compatible with those for steelmaking, vacuum degassing, and hot forming, the Agency is proposing BAT limitations for chromium and lead.

Investment and annual costs for the BAT alternative treatment systems are presented in Table VIII-5.

Rationale for the Selection of the BAT Alternatives

The following discussion presents the rationale for selecting the BAT alternative treatment systems and for determining the effluent flow rates and concentration levels of the limited pollutants.

Treatment Scheme

The alternative treatment systems applied and discharge flow rates, of 3400 and 25 gal/ton, respectively, are based upon a system recycle rate of 99.3 percent. Table X-2 summarizes current applied and discharge flow rates of continuous casting operations for which flow data were provided. The average of the applied flows was 3381 gal/ton. The average of the best discharge flows, considering all plants discharging less than 100 gal/ton, was 27 gal/ton. Therefore, the model value was set at 25 gal/ton. Since this average incorporated data from 23 of the 32 plants reporting a recycle mode of operation, the discharge flow of 25 gal/ton is well documented within this subcategory. Several plants report no discharge of process wastewater.

Filtration is included in both BAT alternative treatment systems in order to provide a reduction in the discharge of particulate metals entrained in suspended solids. Twelve of the thirty-nine plants for which treatment system information was provided use filters. Filtration is also used in other steel industry subcategories and in other industries for the removal of suspended particulates from wastewater streams.

Although sulfide precipitation is not employed in this subcategory, the effectiveness of this treatment technology has been demonstrated in pilot studies and in wastewater treatment applications in other metals manufacturing operations.

Wastewater Quality

The average effluent concentrations (in mg/l) incorporated in each BAT alternative treatment system follows (the maximum values are enclosed in parentheses).

Pollutant	BAT Alt. No.1	BAT Alt. No.2
Chromium	0.10 (0.30)	0.10 (0.30)
Lead	0.10 (0.30)	0.10 (0.30)
Zinc	0.10 (0.30)	0.10 (0.30)

Toxic Metal Pollutants

A. BAT Alternative 1

To determine the effluent concentrations for the toxic metal pollutants, the Agency evaluated analytical data from a variety of sources. Long-term filtration system effluent analytical data, from the plants mentioned previously, were reviewed to determine the toxic metal removal capabilities of filtration systems used in similar wastewater treatment applications. Reference is made to Volume I, Appendix A, for the derivation of 30 day average and daily maximum performance standards.

B. BAT Alternative 2

As noted previously in this section, BAT Alternative 2 incorporates a sulfide precipitation system in addition to the filtration system noted in BAT Alternative 1. As sulfide precipitation technology has not been demonstrated within this subcategory, the capabilities of this technology have been transferred from other metals manufacturing wastewater treatment applications. The toxic metals effluent levels which can be achieved with this treatment technology were developed on the basis of the data review presented in Volume I. The data indicate that average toxic metals effluent concentrations of 0.10 mg/l could be attained with this treatment technology.

Effluent Limitations for BAT Alternatives

The effluent limitations for the BAT alternative treatment systems were calculated by multiplying the model effluent flow and the corresponding concentrations of metals with appropriate conversion factors. Table X-1 presents the effluent limitations developed for each treatment alternative.

Selection of a BAT Alternative

The Agency selected BAT Alternative No.1 as the BAT model treatment system upon which the proposed BAT limitations are based.

Filtration is well demonstrated in the continuous casting subcategory, while sulfide precipitation is not. For this reason, the first alternative was selected as the BAT model treatment system. (See Table X-1).

TABLE X-1
BAT EFFLUENT LIMITATIONS GUIDELINES
CONTINUOUS CASTING SUBCATEGORY

		BAT ALTERNATIVE 1[*]		BAT ALTERNATIVE 2	
		CONCENTRATION BASIS (mg/l)	EFFLUENT LIMITATIONS (kg/kkg of product)	CONCENTRATION BASIS (mg/l)	EFFLUENT LIMITATIONS (kg/kkg of product)
DISCHARGE FLOW (gal/ton)		25	——	25	——
CHROMIUM	AVE.	0.10	0.000010	0.10	0.000010
	MAX.	0.30	0.000031	0.30	0.000031
LEAD	AVE	0.10	0.000010	0.10	0.000010
	MAX.	0.30	0.000031	0.30	0.000031
ZINC	AVE	0.10	0.000010	0.10	0.000010
	MAX	0.30	0.000031	0.30	0.000031

[*] Selected BAT alternative

TABLE X-2

SUMMARY OF FLOWS AND RECYCLE RATES CONTINUOUS CASTING SUBCATEGORY

Plant Code	Applied Flow (gal/ton)	Discharge Flow (gal/ton)	Operating Mode	Basis
0076	1656	0*	RTP 100	DCP
0084A	-	0*	RUP 100	DCP
0248B	2000	0*	RTP 100	DCP
0284A	564	0*	RTP 100	Survey
0496	1542	0*	RTP 100	Survey
0596	5161	0*	RTP 100	DCP
0620A	22	0*	RTP 100	DCP
0672A	547	0*	RTP 100	DCP
0780	1934	0*	RTP 100	DCP
0740A	1415	1.2*	RTP 99.9	DCP
0180	4012	4.0*	RTP 99.9	DCP
0608A	2764	11*	RTP 99.6	DCP
0384A	3281	16*	RTP 97.1	DCP
0620B	2000	24*	RTP 98.9	DCP
0060K	2985	25*	RTP 99.2	Survey
0468F	2187	28*	RTP 98.7	DCP
0684E	1375	49*	RTP 96.5	DCP
0432A	2496	56*	RTP 97.8	DCP
0696A	1341	66*	RTP 95.1	DCP
0548D	3755	79*	RTP 97.9	DCP
0476A	16210	81*	RTP 99.5	DCP
0060H	923	92*	RTP 90	DCP
0384A	7062	98*	RTP 98.6	DCP
0584F	3489	117	RTP 97	Survey
0112D	6408	128	RTP 98	DCP
0468B	927	128	RTP & RUP 86	DCP
0528A	4814	144	RTP 97	DCP
0444	4294	245	RTP 94.3	DCP
0868B	8258	310	RTP 96.2	DCP
0060D	1678	554	RTP 67	DCP
0864C	-	571	-	DCP
0068B	6111	611	RTP 90	DCP
0856F	1278	1278	OT	DCP
0652	1375	1375	OT	DCP
0460A	4509	1527	RTP 66.2	DCP
0204	2543	2543	REU 100	DCP
0860H	5318	5318	RET 100	DCP
0860B	5489	5489	OT	DCP

Average Applied Flow = 3381 gal/ton.
Average Discharge Flow = 552 gal/ton.
"Average of the Best" Discharge Flow = 27 gal/ton.

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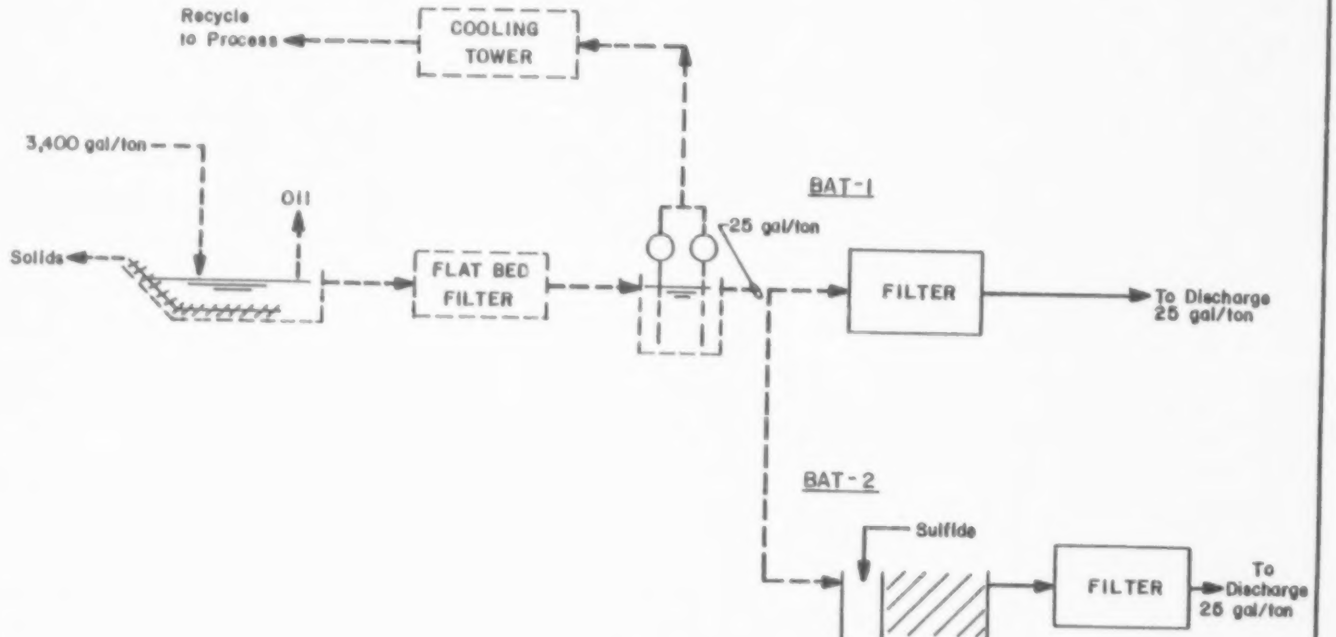
* Flow values marked with an asterisk were used in the "average of the best" calculation.
- Inadequate questionnaire response.


Recycle to Process
COOLING TOWER
3,400 gal/ton
Oil
Solids
FLAT BED FILTER
BAT-1
25 gal/ton
FILTER
To Discharge 25 gal/ton
BAT-2
Sulfide
FILTER
To Discharge 25 gal/ton

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
CONTINUOUS CASTING SUBCATEGORY
BAT TREATMENT MODEL

Dwn.6/11/80

FIGURE X-1

CONTINUOUS CASTING SUBCATEGORY

SECTION XI

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

Introduction

The 1977 Amendments added Section 301(b)(4)(E) to the Act, establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in Section 304(b)(4) - BOD, TSS, fecal coliform, and pH - and any additional pollutants defined by the Administrator as "conventional." On July 28, 1978, EPA proposed that COD, oil and grease, and phosphorus be added to the conventional pollutant list (43 Fed. Reg. 32857). Only oil and grease was added.

BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. BCT requires that limitations for conventional pollutants be assessed in light of a new "cost-reasonableness" test, which involves a comparison of the cost and level of reduction of conventional pollutants from the discharge of POTWs to the cost and level of reduction of such pollutants from a class or category of industrial sources. As part of its review of BAT for certain "secondary" industries, EPA proposed methodology for this cost test. (See 43 Fed. Reg. 37570, August 23, 1978).

Methodology

Reference is made to Volume I for a review of the BCT methodology.

Development of BCT Limitations

The reference POTW treatment cost for the conventional pollutants is $1.34/lb (July 1, 1978). See Section X of Volume I. The conventional pollutant treatment cost for the BCT model treatment system is $0.48/lb. Therefore, the BCT treatment model passes the BCT cost test. The BCT model treatment system includes filtration of the BPT blowdown and is compatible with the BAT model treatment system.

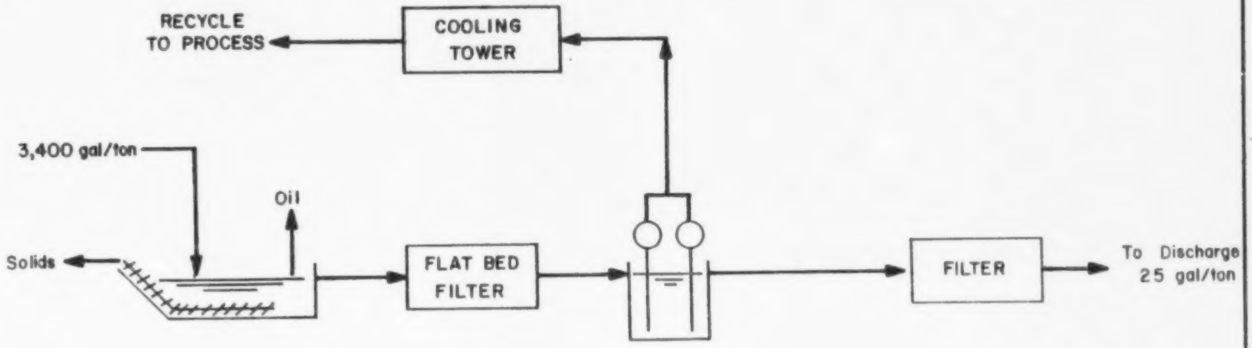
The Agency is proposing BCT limitations for suspended solids, oil and grease, and pH. Reference is made to Appendix A of Volume I for the derivation of performance standards for suspended solids and oil and grease.

Proposed BCT Limitations

The proposed BCT effluent limitations are presented in Table XI-1, while the BCT model treatment system is illustrated in Figure XI-1.

TABLE XI - I
BCT EFFLUENT LIMITATIONS GUIDELINES
CONTINUOUS CASTING SUBCATEGORY

		BCT MODEL	
		CONCENTRATION BASIS (mg/l)	EFFLUENT LIMITATIONS (kg/kkg of product)
DISCHARGE FLOW (gal/ton)		25	——
TOTAL SUSPENDED SOLIDS	AVE.	15	0.0016
	MAX.	40	0.0043
OIL AND GREASE	AVE.	——	——
	MAX.	10	0.0010
pH		Within the range 6.0 to 9.0	


RECYCLE TO PROCESS
COOLING TOWER
3,400 gal/ton
Oil
Solids
FLAT BED FILTER
FILTER
To Discharge 25 gal/ton

ENVIRONMENTAL PROTECTION AGENCY

STEEL INDUSTRY STUDY
CONTINUOUS CASTING SUBCATEGORY
BCT MODEL

Dwn.10/29/80

FIGURE XI-1

CONTINUOUS CASTING SUBCATEGORY

SECTION XII

EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF NEW SOURCE PERFORMANCE STANDARDS

Introduction

A new source is defined as any source constructed after the proposal of New Source Performance Standards (NSPS). The effluent standards, which must be achieved by new sources, are to specify the degree of effluent reduction achievable through the application of the Best Available Demonstrated Control Technology (BADCT), including, where applicable, a standard permitting no discharge of pollutants. This section identifies the treatment alternatives considered by the Agency for NSPS and the resulting effluent standards. In addition, the rationale for selecting the NSPS model treatment system, flow values, and effluent standards is presented.

Identification of NSPS

A. NSPS Alternative 1

NSPS treatment Alternative No. 1 (illustrated in Figure XII-1), includes the BPT model and BAT-1 treatment components discussed in Sections IX and X. In this system, process wastewaters are treated initially by a scale pit equipped with a drag link conveyor and oil removal facilities. The scale pit effluent is then delivered to a well designed flat bed filter in order to provide the maximum removal of suspended matter. Approximately 99% of the filter effluent is returned to the process through a cooling tower. The remaining 25 gal/ton of the filter effluent is discharged to a receiving stream.

B. NSPS Alternative 2

NSPS Alternative No. 2, which is the same as BAT Alternative No.2, includes a sulfide precipitation step to remove toxic metals. Refer to Figure XII-1. The blowdown from the NSPS Alternative 1 is treated with sulfide. The precipitate which forms is then removed in a polishing filter. The 25 gal/ton discharge flow is maintained in this alternative.

Rationale for Selection of NSPS

The NSPS alternatives for the continuous casting subcategory are similar to the BPT model, BAT-1, and BAT-2 treatment systems described in Sections IX and X. Therefore, the rationale presented in those sections is applicable to NSPS and is not repeated. Both NSPS treatment alternatives for the continuous casting subcategory are addressed in the paragraphs which follow.

Treatment Schemes

As noted in Section X, the use of filtration is documented, not only within the steel industry, but also within the continuous casting subcategory. With the exception of sulfide precipitation, the other treatment technologies are also well demonstrated within the continuous casting subcategory. The resulting effluent wastewater quality for the NSPS alternatives is presented in Table XII-1. As noted in Section X, effluent levels of the limited pollutants were based upon the capabilities of the various wastewater treatment technologies. The pollutants listed in Table XII-1 include only those pollutants which are proposed for limitation at BAT (refer to Section X for the factors considered in selecting these pollutants).

Flows

The applied and discharge flows developed for BAT are applicable to both NSPS alternatives as well. Plants within this subcategory have demonstrated the ability to achieve effluent flows of 25 gal/ton or less. The recycle rate of 99.3%, defined by the applied and discharge flows, is also well demonstrated in the continuous casting subcategory.

Selection of NSPS Alternative

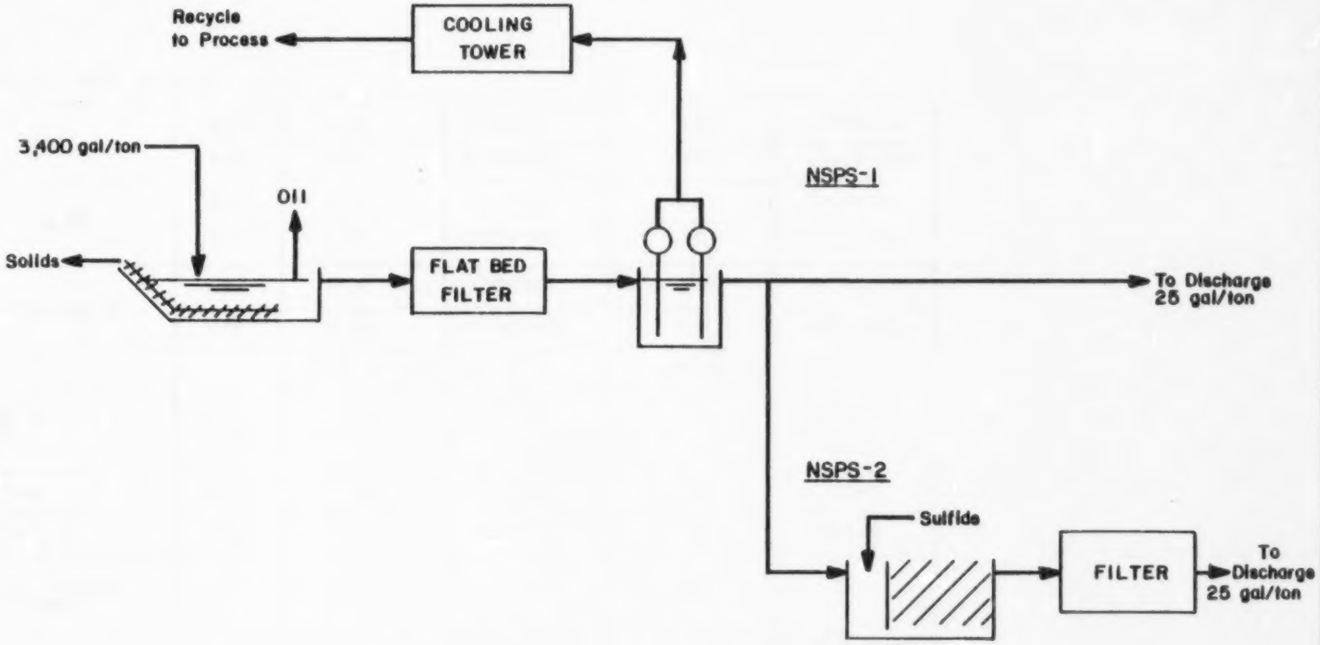
NSPS Alternative No.1 has been selected as the NSPS model treatment system upon which the proposed NSPS effluent standards are based. Sulfide precipitation technology is not demonstrated in this subcategory.

The proposed NSPS effluent standards are presented in Table XII-1 in the column for the first NSPS treatment alternative. The Agency is also considering establishing NSPS at zero discharge based upon the demonstrated performance of several plants in the subcategory.

TABLE XII-1
NEW SOURCE PERFORMANCE STANDARDS
CONTINUOUS CASTING SUBCATEGORY

		NSPS ALTERNATIVE 1*		NSPS ALTERNATIVE 2	
		CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of product)	CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of product)
DISCHARGE FLOW (gal/ton)		25	——	25	——
TOTAL SUSPENDED SOLIDS	AVE.	15	0.0016	15	0.0016
	MAX.	40	0.0043	40	0.0043
OIL AND GREASE	AVE.	——	——	——	——
	MAX.	10	0.0010	10	0.0010
pH		Within the range 6.0 to 9.0		Within the range 6.0 to 9.0	
CHROMIUM	AVE.	0.10	0.000010	0.10	0.000010
	MAX.	0.30	0.000031	0.30	0.000031
LEAD	AVE.	0.10	0.000010	0.10	0.000010
	MAX.	0.30	0.000031	0.30	0.000031
ZINC	AVE.	0.10	0.000010	0.10	0.000010
	MAX.	0.30	0.000031	0.30	0.000031

* Selected NSPS alternative


Recycle to Process
COOLING TOWER
3,400 gal/ton
Oil
Solids
FLAT BED FILTER
NSPS-1
To Discharge 25 gal/ton
NSPS-2
Sulfide
FILTER
To Discharge 25 gal/ton

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STEEL INDUSTRY STUDY
CONTINUOUS CASTING SUBCATEGORY
NSPS TREATMENT MODEL

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FIGURE XII-1

CONTINUOUS CASTING SUBCATEGORY

SECTION XIII

PRETREATMENT STANDARDS FOR THE DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS

Introduction

This section discusses the alternative control and treatment systems available for continuous casting operations which discharge wastewaters to publicly owned treatment works (POTWs).

The main factors considered in the development of pretreatment standards are: (1) the need to ensure that the continuous casting wastewaters are treated sufficiently to avoid overloading POTW systems, and (2) that provisions for toxic pollutant removal are incorporated such that these pollutants do not interfere with or pass through the POTW, or are not otherwise incompatible with POTW operations.

The Agency has given separate consideration to new (PSNS) and existing (PSES) continuous casting operations discharging to POTWs. However, it concluded that identical pretreatment models and standards should be developed for both types of sources. Therefore, the models and standards for new and existing sources are not discussed separately.

General Pretreatment Regulations, 40 CFR Part 403, are applicable to all continuous casting sources. A discussion of the general pretreatment and categorical pretreatment standards applying to continuous casting operations follows.

General Pretreatment Standards

For detailed information concerning Pretreatment Standards, refer to 43 FR 27736-27773, "General Pretreatment Regulations for Existing and New Sources of Pollution," (June 26, 1978). In particular, 40 CFR Part 403 describes national standards (prohibited discharges and categorical standards), revision of categorical standards through removal allowances, and POTW pretreatment programs.

In establishing pretreatment standards for continuous casting operations, the Agency gave primary consideration to the objectives and requirements of the General Pretreatment Regulations. In addition, the Agency considered other factors specifically applicable to continuous casting operations.

Although wastewaters from five continuous casting operations are discharged to POTWs, the POTWs are not designed to treat the toxic metal pollutants (chromium, lead, and zinc) present in continuous casting wastewaters. Instead, POTWs are designed to treat biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform bacteria, and pH. Toxic metal removal by POTWs is incidental to the POTW's main function of treating conventional pollutants.

POTWs have historically accepted many pollutants in amounts well above their capacities to treat them adequately. The problems of municipal sludge disposal are becoming increasingly difficult to resolve. Pretreatment standards must address toxic pollutant removal. This will greatly reduce the transfer of these pollutants to POTWs, where they concentrate in the sludges.

Due to the presence of toxic metal pollutants in continuous casting wastewater, pretreatment must be provided to ensure that these pollutants do not interfere with or pass through the POTW, or are not otherwise incompatible with POTW operations, or cause harm to the treatment plant. In general, the alternative pretreatment systems are comparable to the BAT alternative treatment systems. Pretreatment standards for suspended solids and oil and grease are not proposed. These pollutants, in amounts present in continuous casting BPT effluents, are compatible with POTW operations and can be effectively treated at POTWs. However, based upon the information and data presented in Volume I, the Agency concludes that pretreatment standards for the toxic metals found in continuous casting wastewaters should be proposed at the same levels as the respective NSPS. Chromium, lead, and zinc concentrate in POTW sludges. Therefore, the Agency believes that it is necessary to control the discharge of these toxic metals to POTWs.

Alternative Pretreatment Models

The two alternative pretreatment models are identical to the two alternative NSPS treatment models discussed in Section XII. Refer to Section XII for descriptions and justifications of these model treatment systems. Refer to Figure XIII-1.

Selection of PSES/PSNS Alternative

The Agency selected PSES/PSNS Alternative No. 1 as the model treatment system upon which the proposed treatment effluent standards are based. This alternative was selected because filtration technology is widely used in continuous casting facilities and is effective in reducing toxic metal loadings to relatively low levels. Pretreatment model cost data are presented with NSPS model cost data in Table VIII-7.

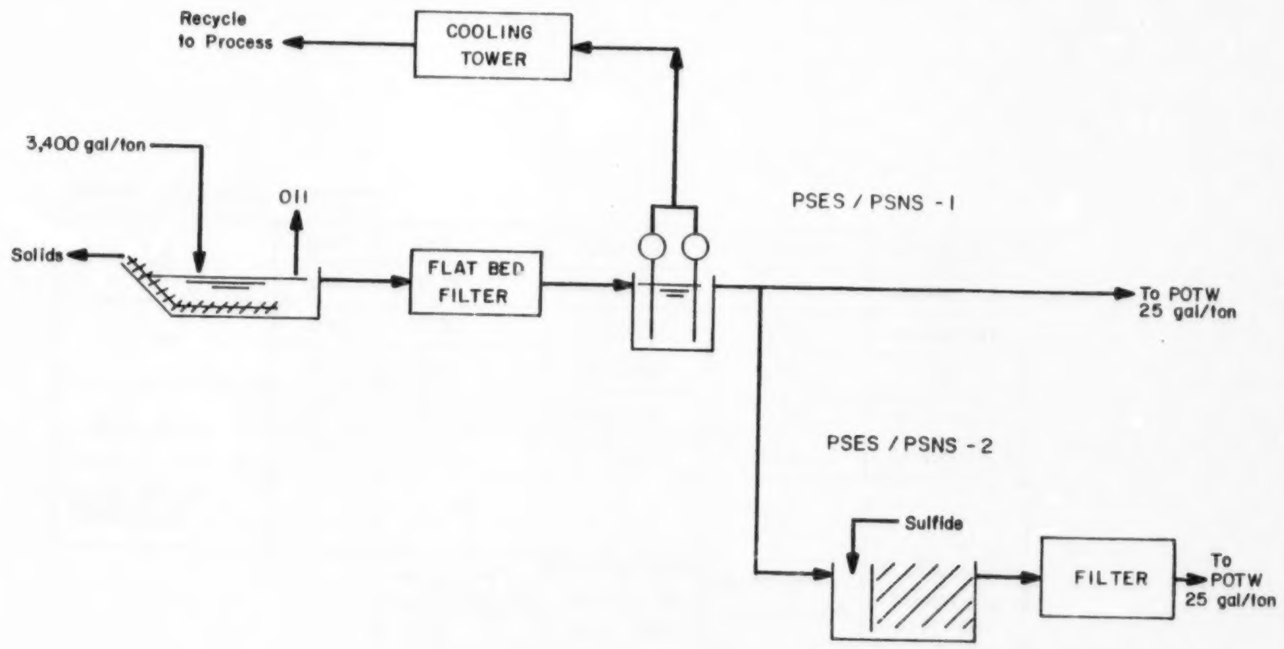
The proposed PSES/PSNS effluent standards are presented in Table XIII-1. They are designated by an asterisk. No effluent standards are proposed for suspended solids and oil and grease, as these are conventional pollutants which can be effectively treated in POTWs. However, control of suspended solids is an important factor in the control of toxic metals.

TABLE XIII-1

PRETREATMENT EFFLUENT STANDARDS (EXISTING AND NEW SOURCES)
CONTINUOUS CASTING SUBCATEGORY

		PSES/PSNS ALTERNATIVE 1*		PSNS/PSES ALTERNATIVE 2	
		CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of product)	CONCENTRATION BASIS (mg/l)	EFFLUENT STANDARDS (kg/kkg of product)
DISCHARGE FLOW (gal/ton)		25	——	25	——
CHROMIUM	Ave.	0.10	0.000010	0.10	0.000010
	Max.	0.30	0.000031	0.30	0.000031
LEAD	Ave.	0.10	0.000010	0.10	0.000010
	Max.	0.30	0.000031	0.30	0.000031
ZINC	Ave.	0.10	0.000010	0.10	0.000010
	Max.	0.30	0.000031	0.30	0.000031

*Selected PSES/PSNS alternative


Recycle to Process
COOLING TOWER
3,400 gal/ton
Oil
Solids
FLAT BED FILTER
PSES / PSNS - 1
To POTW 25 gal/ton
PSES / PSNS - 2
Sulfide
FILTER
To POTW 25 gal/ton

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STEEL INDUSTRY STUDY
CONTINUOUS CASTING SUBCATEGORY
PRETREATMENT MODEL

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FIGURE XIII-1

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-083/4623